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APPLIED MECHANICS REVIEWS

VOL. 8, NO. 5 MARTIN GOLAND *Editor* MAY 1955

IMPORTANCE OF ENGINEERING SCIENCE ON THE FUTURE OF THE PROFESSION

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THE shortage of engineers has presented to us entirely new concepts concerning the engineering profession. It has caused us to examine more closely not only the preparation of the engineer for his profession but also the availability of young men for such training. We have thus come upon the startling fact that, because of the limited number of young men of college age who have the necessary level of intelligence to accomplish a rigorous engineering course, the number available for training in engineering is limited. An even more important fact is that we have now reached the limit of qualified young men available for training in engineering in terms of percentage of population. Although there is immediately ahead of us an actual increase in the number of young men who will be available, the percentage in each age group available for training in engineering cannot increase. The conclusion must be reached, therefore, that within the pattern in which we utilize engineers in our society and within the pattern of training now in operation in this country, the shortage of engineers we are now experiencing is here to stay.

Many who are in the field of applied mechanics and related subjects are in an excellent position to appraise the extent of the great expansion of utilization of engineers that our present and future society demands. If we look backward as well as forward, we are impressed with the fact that this demand for engineering service is continually accelerating. If we think, therefore, of the increasing service per hundred thousand of population and set next to it the fact that the number of engineers per hundred thousand of population has now reached the maximum of availability and thus is leveling off, we realize that something must be done about the widening gap between service need and manpower supply.

I have said that the shortage is here to stay provided two conditions now in vogue are continued, namely, the present pattern of utilization of engineers, and the pattern of preparation of the engineers. While there are admittedly other contributing factors to aid in sustaining the shortage, I believe these two factors to be the most important. I am convinced also that they are the ones to which we must address our attention and our energies if we are to improve the situation.

You who are in applied mechanics and related fields, it seems clear to me, are in a strategic position to evaluate the technical trends in engineering in all its phases. You are aware of the increasing application of mathematics and the basic physical sciences. You are also aware of the expanded activity in fields related to thermodynamics, fluid mechanics, electronics, and electromagnetism. Many of you are also aware of the nature of the development of nuclear engineering. Since your work is common to all of the engineering curricula, you are, therefore, able to evaluate the way in which strengthening in these subjects is permeating, or failing to permeate, subsequent courses in the curricula.

UNDERGRADUATE MECHANICS TEACHING

You will recall that thirty years ago a major number of our engineering colleges were teaching mechanics without the use of the calculus. In part this was due to the fact that a four-year curriculum has to be telescoped to a considerable extent in order to begin, as most schools do, with algebra and trigonometry and, at the same time, end with anything like a useful point at the end of the fourth year. This telescoping forced many schools to teach mechanics at a time when the calculus was not fully available. At that time also, many people were experimenting with the curriculum, in the hope that something could be devised that would require only a minimum of technical competence and, at the same time, prepare a man for upper level management in industry without the burden of a great deal of engineering education. These factors, when coupled together, achieved a status of great weakness in the curricula of those days.

Into this situation came a new and stimulating leader in undergraduate mechanics teaching. Through his preparation of new textbooks in this field, Professor Timoshenko brought to the classroom the teaching prevalent on the Continent. He and his graduate students have had a profound effect upon mechanics and related fields in achieving a more advanced viewpoint and competence in our engineering schools. It was fortunate that the general advancement of this field took place well before the country's entry into World War II.

The function of the engineer is to engineer something into existence. This may be done not only through analysis and synthesis using analytical tools, but it may also be done by trial and error

or with the use of models or analogs. It is not always necessary that the engineer arrive at precise accuracy, because the extent of the function may vary considerably and the design may have to be, in fact, an envelope of a lot of circumstances of function. The work of the engineer is sharply separated from the work of the scientist, who is seeking laws of behavior and who has reached his goal when he has determined such laws within the prescribed conditions.

In the training of engineers, the study of such subjects as mechanics, fluid mechanics, thermodynamics, and similar engineering sciences marks the departure from the field of science into the field of engineering. It is the beginning of the training for competence in analysis and synthesis. It is thus the beginning of true engineering.

ABILITY TO ATTACK DESIGN PROBLEMS

The ability of an engineer is determined by his power of attack on design problems, together with the insight into behaviors of things that are not yet built, but which he has under contemplation. Thus the range and depth of his training will determine the power with which he may be able to attack a design situation. More particularly, it is to be noted that the engineer works on his problem when it is only a figment of the imagination. He must understand the concepts of possible actions so thoroughly that he may think of them with great ease. His resourcefulness will be measured by the facility with which he may be able to visualize accurately and thus to anticipate possible difficulties. His analytical ability will be used largely to test quantitatively the function of the thing which he has under contemplation.

It is clear that, in these terms, good men in the field of mechanical or civil engineering, or in the apparatus side of chemical and electrical engineering, must have knowledge of materials and their behavior under service conditions. Corrosion, biaxial and triaxial stress states, fatigue, vibration, corrosion under stress, behavior at advanced temperatures, and surface phenomena lie in the range of modern designing. The physicist is just beginning to give detailed attention to the solid state. The engineer has, for many years, been obliged to design under these conditions, often with a considerable inadequacy. People in mechanics, however, are obliged to take cognizance of these factors and to assist in protecting the adequacy of design even though it may not be refined to the point which someday we may be able to achieve.

A competent person in mechanics is aware of the danger of overdesign, in the sense of providing excess material at a point where analysis is difficult. Redundancy, in mechanics, is just as much of a sin as weakness. It is of a special importance in situations involving fatigue, vibration, biaxial and triaxial stress, residual stress, and thermal problems.

People working in the field of mechanics are, in my opinion, working in the range which defines the adequacy of the curriculum. They draw together, and give meaning to, the basic sciences. They set the stage for the exploration of engineering situations and courses to follow. It is their privilege and responsibility, therefore, to see to it that the degree of competence is achieved in analysis and synthesis, and that the stage is set for a high-level application of this competence to more extended engineering design in subsequent courses.

MACHINE-DESIGN COURSES INADEQUATE

I cannot refrain from making an observation concerning the field of mechanical engineering that seems to have a fairly general application. This is that the courses in machine design are pretty generally antiquated. There is more likelihood that modern design is met in mechanics and in the consideration of materials than in courses in machine design. It may be that those in mechanics will have to take over the work in machine design in order to bring it up to an adequate level. Already, in many schools, the work in mechanics is so good that the students are critical of their work in machine design and other courses that follow thereafter. This situation will force an evolution in the later courses of the curricula that is long overdue. It is a good illustration of the power that lies in the area of mechanics in the practice of engineering, and the extent to which this power may be applied to bring about more advanced considerations of engineering in the latter part of the engineering curricula.

CULTURAL SUBJECTS FOR ENGINEERS

Also, I cannot refrain from mentioning another important contribution which lies in the power of the people in mechanics and similar subjects. This is the interjection into engineering curricula of truly cultural values. In the first place, it should be a part of the teaching of mechanics and other applied science courses to mention the great philosophers, scientists, and engineers whose discoveries opened up new possibilities for the development of our profession. Many of the greatest minds that ever lived have participated in making important contributions to the engineering sciences. This fact strengthens the concept that engineering is truly a learned profession; that it ranks with the field of philosophy in serious contemplation; and that it is essentially an achievement of the intellect and not of materialism. To this end, every person in the applied sciences should have available for ready reference Wolf's great "History of Science, Technology and Philosophy," and should bring to the attention of their students the circumstances under which these great achievements came about and something of the personalities involved and the times in which they lived. Students should be brought to the realization that they also are privileged to work in the fields which were so attractive to some of the greatest men of history.

I would also like to inject one more word of caution at this point. The line between science and engineering is sometimes very hazy. Engineers who have taken advanced work in the sciences are often intrigued by the notion of giving themselves status through calling themselves scientists. Whether a man is a scientist or an engineer depends upon how he functions and not on how he was trained. It is important also that one's teaching reflect this fact and that the engineer be trained for his function, which is engineering and not science. I have already pointed out the significant difference between these two fields. The creative function of the engineer is indeed a worthy calling. It is made more worthy by the attitude and stature of those who are good in this field and by those who can increase the conscientiousness of the high level of intellectual achievement and function that the engineer possesses and performs.

SUMMARY

In summary, I call attention to the changing power of attack that is derived from the strengthening of that part of the engineering curricula which deals with the engineering sciences and which consists of a wider knowledge of physics and chemistry and the use of more advanced methods in mathematics. The further strengthening of the curricula will come when these advances are continued into the subjects which follow in the curricula. I urge all in the engineering sciences to exert their influence to bring about a widening of scientific knowledge on the part of engineers; a strengthening of the analytical tools; and, through the maintenance of a broad approach by the inclusion of the many factors involved in each situation before the engineer, to encourage the exercise of broad judgment and the making of practical decisions.

Books Received for Review

BINDER, R. C., Fluid mechanics, 3rd ed., New York, Prentice-Hall, Inc., 1955, x + 388 pp. $7.65.

COMSTOCK, G. F., Titanium in iron and steel, New York, John Wiley & Sons, Inc.; London, Chapman & Hall, Ltd., 1955, xii + 294 pp.

DRIGGS, I. H., AND LANCASTER, O. E., Gas turbines for aircraft, New York, The Ronald Press Co., 1955, xv + 249 pp. $10.

ERDÉLYI, A., MAGNUS, W., OBERHETTINGER, F., AND TRICOMI, F. G., Tables of integral transforms. Vol. III (Bateman Manuscript Project), New York, Toronto, London, McGraw-Hill Book Co., Inc., 1955, xvii + 292 pp. $6.50.

GAMSE, S. M., AND GOLDSCHER, A. J., Technologie der Herstellung von Grosswasserturbinen (translated from Russian), Berlin, VEB Verlag Technik, 1954, 362 pp.

GELEJI, A., Walzwerks- und Schmiedemaschinen (translated from Hungarian), Berlin, VEB Verlag Technik, 1954, 718 pp.

LOÈVE, M., Probability theory. Foundations. Random sequences, Toronto, New York, London, D. Van Nostrand Co., Inc., 1955, xv + 515 pp. $12.

PARCEL, J. I., AND MOORMAN, R. B. B., Analysis of statically indeterminate structures, New York, John Wiley & Sons, Inc.; London, Chapman & Hall, Ltd., 1955, xiv + 571 pp. $9.50.

POPOFF, K., Die Hauptprobleme der ausseren Ballistic im Lichte der modernen Mathematik, 2nd ed., Leipzig, Akademische Verlagsgesellschaft Geest & Portig K.-G., 1954, xv + 277 pp., 20 figs.

REDDICK, H. W., AND MILLER, F. H., Advanced mathematics for engineers, 3rd ed. (revised by Miller, F. H.,) New York, John Wiley & Sons, Inc.; London, Chapman & Hall, Ltd., 1955, xiv + 548 pp. $6.50.

RICHTER, O., VOSS, R. v., AND KOZER, F., Bauelemente der Feinmechanik (6th ed., edited by Kozer, F.), 1954, Berlin, VEB Verlag Technik, xvi + 488 pp.

RUDINGER, G., Wave diagrams for nonsteady flow in ducts, Toronto, New York, London, D. Van Nostrand, Inc., 1955, xi + 278 pp. $6.

WINTER, H., Die tragfähigste Evolventen-Geradverzahnung. Untersuchung und Vergleich verschiedener Verzahnungssysteme (edited by Niemann, G.) (Schriftenreihe Antriebstechnik, H. 15), Braunschweig, Friedr. Vieweg & Sohn, 1954, 99 pp., 142 pp. of figs., diagrams. DM 17.80.

STUDIES IN MATHEMATICS AND MECHANICS (Presented to R. von Mises by Friends, Colleagues, and Pupils), New York, Academic Press, Inc., 1954, ix + 353 pp. $9.

Letters to the Editor

1246. Re AMR 7, Rev. 3368 (October 1954): R. W. Schrage, A theoretical study of interphase mass transfer.

Author cannot agree that the distribution function used for molecules emitted from the surface of the condensed phase is unreasonable. Calculations of the rate of molecular emission have been directly or implicitly based on this distribution by many workers. This calculated rate has been largely confirmed by experiment, as discussed in the book. Furthermore, while the exact form of the modified distribution function used later for molecules approaching the condensed phase may be uncertain, it was not used without explanation and it is not inconsistent with "the physical requirements."

According to the reviewer the author conceives of interphase mass transfer "controlled solely by the properties of the gas phase and entirely independent of the properties of the liquid phase—which are nowhere mentioned." This statement is incorrect; indeed, the reviewer himself refers to the liquid phase surface temperature T_s, which is used throughout the book to characterize the molecules emitted from the surface.

The reviewer took the liberty of rearranging (3.1–15a) which he says expresses one unknown quantity in terms of another. The original form of this equation merely defined a parameter of some importance in developing a final equation for the rate of interphase mass transfer which appears later as (3.2–3). Similarly the reviewer states that (5.4–8) for the quantity B expresses one unknown by another. Equation (5.4–8) is also an intermediate step and B does not appear in any of the final results of this development.

The alleged error referred to by the reviewer between (3.1–1) and (3.1–2) is certainly not clear since neither of the definite integrals he mentions is involved in this step. Apparently to illustrate the consequences of this "error" elsewhere the reviewer later attempts to calculate the average kinetic energy of a molecule at the phase interface from $\epsilon = (E/w)$, the ratio of energy flow to mass flow. (This ratio is actually energy per unit mass rather than molecular energy, but this is a minor point.) Since E is the total energy flow (relative to a stationary observer) in a steady flow system, this ratio is not the internal energy of the gas. As the interphase mass transfer rate approaches zero this ratio should and does approach the enthalpy of a perfect monatomic gas which is $(5/2)\ RT = (3/2)\ RT + PV$. The value $(3/2)\ RT$ is the internal energy of a perfect monatomic gas, not $2RT$ which the reviewer gives. Thus the basis for the reviewer's argument is erroneous.

The last paragraph of the review is misleading since no meaningful experimental evidence could be found to test (neither confirming nor denying) any theories on this subject.

R. W. Schrage, USA

Theoretical and Experimental Methods

(See also Revs. 1264, 1266, 1272, 1277, 1281, 1283, 1285, 1287, 1294, 1309, 1310, 1320, 1331, 1342, 1345, 1420, 1425, 1432, 1434, 1464, 1517, 1518)

1247. Perron, O., The theory of continued fractions. Vol. I. Elementary continued fractions [Die Lehre von den Kettenbrüchen. Vol. I, Elementare Kettenbrüche], 3rd rev. and enlarged ed., Stuttgart, B. G. Teubner Verlagsgesellschaft, 1954, vi + 194 pp.

Volume deals with subject from arithmetical viewpoint. Chapters and headings are nearly the same as in previous edition (1929), but more material has been added without increasing the size by using results available since the last edition. Book is written on an elementary level and author has not beclouded the work with hieroglyphics of some "modern" concepts of mathematics. Continued fractions arise in a number of applied fields and are important in computational work, as technique can be used to approximate analytic functions. Volume is well written and is a valuable aid for understanding of subject.

Y. L. Luke, USA

1248. Edwards, J., A treatise on integral calculus with applications, examples, and problems. Vols. I, II, New York, Chelsea Publishing Co., 1954, xxi + 907 pp., xv + 980 pp. $6.50 ea.

These are modestly priced reprints of previously published works and, as such, offer the advantages associated with reprints of this type. Vol. II is devoted to subject matter which is often termed "analysis." Volume I, however, is definitely integral calculus; it not only covers the portions of the field usually presented in college courses but also fills the gap beyond, embracing with continuity and clarity the usual pertinent topics presented in advanced courses for engineers.

Reviewer finds these texts extremely well written, being neither too verbose nor too terse. They are particularly recommended for those needing basic background information on the topics covered in the afore-mentioned advanced courses for engineers.

E. J. McBride, USA

1249. Luke, Y. L., On the computation of oscillatory integrals, *Proc. Camb. phil. Soc.* **50, 2,** 269–277, 1954.

Author evaluates integrals of the form $\int_a^b f(y)e^{i\lambda y}\,dy$ in terms of series of central differences of the function $f(y)$, each difference being multiplied by an appropriate coefficient. These coefficients are given in terms of tabulated functions in a form particularly useful when $f(y)$ is determined at an odd number of equally spaced intervals. When $f(y)$ is not a polynomial, the series does not terminate and there is a comprehensive treatment of the truncation error.

C. C. Gotlieb, Canada

1250. Evans, R. L., Errors in asymptotic solutions of linear ordinary differential equations, *Quart. appl. Math.* **12,** 3, 295–300, Oct. 1954.

When asymptotic series are used in approximating the solutions of linear ordinary differential equations, it is desirable to have an estimate of the accuracy of that approximation. Older estimates of this kind are either difficult to obtain or of limited applicability. A simple method of making such estimates is presented here. It applies to linear second-order differential equations, and for higher-order differential equations it can be replaced by another and more laborious method. The results of this article can also be used to determine the number of terms of an asymptotic expansion giving the best approximation to the desired solution.

From author's summary

1251. Burford, T. M., Analysis of systems involving difference-differential equations, *J. appl. Phys.* **25,** 9, 1145–1148, Sept. 1954.

Equations of title arise in control-system analysis where time delays are present. If characteristic equation has a single time delay, author develops a graphical technique based on elementary conformal mapping theory for approximate determination of system stability.

Y. L. Luke, USA

1252. Minorsky, N., Some applications of difference-differential equations (in French), *R. C. Semin. mat. fis. Milano* **23** (1952), 164–181, 1953.

Author considers title equations (linear and nonlinear) which arise in problems involving delayed actions. Linear system is mass-spring with damping; same for nonlinear with addition of cubical stiffness. Linear problem depends on stiffness parameter. Graphical technique is given to determine parameter values for which response is purely sinusoidal. Nonlinear problem (stroboscopic system) requires local application of nonlinear method to obtain conditions of stationary regime.

Y. L. Luke, USA

1253. Babkin, B. N., Chaplígin's solution of one boundary-value problem for an ordinary differential equation of the second order (in Russian), *Prikl. Mat. Mekh.* **18, 2,** 239–242, Mar./Apr. 1954.

Given a type of boundary-value problem, $y'' - f(x,y) = 0$, $y(a) = A$, $y(b) = B$, f and f_y continuous, $f_y \geqslant 0$, $a \leqslant x \leqslant b$ and $-\infty < y < \infty$, author proves uniqueness of $y(x)$, proves a theorem of differential inequalities for upper and lower functional approximations to $y(x)$, gives construction for sequences of upper and lower functional approximations to $y(x)$, and proves uniform convergence for these sequences on [0.1].

Let $\alpha(x) = v'' - f(x,v)$, $v(a) = A$, $b(v) = B$. If $\alpha(x) \leqslant 0$, then $v(x)$ is an upper approximation to $y(x)$ and $v(x) \geqslant y(x)$ on $[a,b]$. If $\alpha(x) \geqslant 0$, then $v(x) \leqslant y(x)$ and $v(x)$ is a lower approximation to $y(x)$. To construct an upper $v(x)$, put $v(x) = z(x) + \eta(x)$, where $z(x)$ is arbitrary, $\eta''(x)$ is continuous, $\eta(x)$ satisfies $\eta'' + |\alpha(x)| = 0$, $\eta|(a) = \eta|(b) = 0$, and $\alpha(x) = z'' - f(x,z)$. To construct a lower $v(x)$, change $\eta(x)$ to satisfy $\eta'' - |\alpha(x)| = 0$. The sequences of upper functions $\{v_n(x)\}$, $(n = 1, 2, \ldots)$, converge uniformly to $y(x)$ when $v_n(x) = v_{n-1}(x) - \delta_{n-1}(x)$, $\delta_{n-1} - M\delta_{n-1} - \alpha_{n-1}(x) = 0$, $\delta_{n-1}(a) = \delta_{n-1}(b) = 0$, $\alpha_{n-1}(x) = v''_{n-1} - f(x,v_{n-1})$, $\delta_0(x) = \delta(x)$, $\alpha_0(x) = \alpha(x)$, and $M = \sup f_y$. Sequences of lower functions converge uniformly to $y(x)$.

These problems can also be worked by routine numerical procedure; e.g., AMR **3,** Rev. 1824.

K. D. Saunders, USA

1254. Burgerhout, Th. J., On the numerical solution of partial differential equations of the elliptic type. I, *Appl. sci. Res. (B)* **4,** 3, 161–172, 1954.

Replacement of partial differential equation $z_{xx} + z_{yy} + pz + \phi(x,y) = 0$ by set of finite-difference equations for $n \times n$ mesh points, with z given on square boundary, leads to matrix equation $A_{nn}\,z = b$, with solution $z = A_{nn}{}^{-1}b$. Matrix A_{nn} is of order n^2, and is partitioned into submatrixes of order n. All submatrixes are null except diagonal terms, called A_n, and terms adjacent to diagonal which are unit matrixes I_n. Matrix A_n is of form arising from solution of ordinary differential equation $z'' + pz + \phi(x) = 0$ with given terminal values. Diagonal terms are constant a, adjacent terms unity, all others zero. This is special case of "chain matrix," defined by property $a_{r,r-1} + a_{r,r+1} = a_{r-1,r} + a_{r+1,r}$ with $a_{rs} = 0$ if $r,s = 0$ or $n+1$. Chain matrix is therefore completely defined by first row. Properties of A_n are established and used to effect relatively easy inversion of A_{nn}, whose form is identical with that of A_n when numbers a, 1, 0 are replaced by A_n, I, and 0. Numerical example is given for $p = 0$. Extension is discussed to rectangular and irregular boundary shapes.

Reviewer finds many of these results in previous paper by O. Karlqvist [AMR **6,** Rev. 2982], but the explicit formulas and directions for evaluation of $A_{nn}{}^{-1}$ seem to be original.

L. Fox, England

1255. Liebmann, G., Resistance-network analogues with unequal meshes or subdivided meshes, *Brit. J. appl. Phys.* **5,** 10, 362–366, Oct. 1954.

Solution of partial differential equations by difference methods requires special treatment near a boundary whose geometry is complicated or when the function is rapidly changing, as near a singularity. To achieve high accuracy, usual technique is to work with unequal mesh lengths or locally subdivided meshes. Paper develops resistance-network analogs for solution of finite difference algorithm using these mesh types.

Y. L. Luke, USA

1256. Meixner, J., and Schäfke, F. W., Mathieu functions and spheroidal wave functions with applications to physical and technical problems [Mathieusche Funktionen und Sphäroidfunktionen] (Grundlehren der mathematischen Wissenschaften, Bd. 71), Berlin, Springer-Verlag, 1954, xii + 414 pp., 29 figs. DM 49.

Functions in title arise by separation of wave equation $\Delta\mu + k^2\mu = 0$ in various coordinate systems. Volume gives excellent theoretical and applied coverage, and this dual treatment should

prove valuable to research workers. Tome is divided into four chapters. In addition, there are an introduction, bibliography, and index. An appendix lists the notation, page(s) where defined and where principal results involving nomenclature are found. Introduction is short but meaty. History of functions is outlined. Various aspects of problems are summarized (series representations, integral representations, addition theorems, etc.) along with authors (cross-referenced to bibliography) who have contributed to their study. Applications to applied problems are similarly treated.

First chapter is devoted to basic analytic results required for theoretical treatment of subject. For instance, an outline of theory of entire functions of finite order is presented. Other topics include the eigenvalue problem with parameters, asymptotic expansions, etc. Second and third chapters give a complete treatment of Mathieu functions and spheroidal wave functions, respectively. Chapter four (65 pages) gives applications to applied problems. Topics include mechanical and electrical vibrations, elasticity, structures, aerodynamics, acoustics, and others.

Volume is well written and fills a gap in field of higher transcendental functions. Mathematical treatment coupled with applications to physical problems make volume a worthy addition to a scientific library. Y. L. Luke, USA

1257. **Riekstins, E. J., Certain new formulas for Laplace transformations** (in Russian), *Prikl. Mat. Mekh.* **17**, 6, 761–768, Nov./Dec. 1953.

Author derives formula

$$\Phi_n(\alpha,t) = L^{-1}\{(\alpha + p^{1/2})^{-n}\} = [2/(n-1)!(\pi t)^{1/2}]\int_0^\infty \tau^{n-1}(2t^{1/2})^{n-1}e^{-2\alpha\tau t^{1/2}}e^{-\tau^2}\tau d\tau$$

and explores its possibilities. For example, he relates Φ_n to the Hermite polynomials, and finds several recursion formulas.

R. E. Gaskell, USA

1258. **Ludwig, R., Iterative solution of equations and systems of equations. Part I** (in German), *ZAMM* **34**, 6, 210–225, June 1954.

Paper is concerned with the numerical solution of an equation with one unknown, $\phi(x) = 0$. (The case of several equations in several unknowns, though included in the title, is left for a later paper.) It lists a large number of iterative methods for solving such problems and discusses them systematically. They are classified according to "order," which measures the speed of convergence. Processes up to the fourth order, based on ϕ and its first four derivatives, are derived and (sufficient) conditions for their convergence given. A frequently used method for improving convergence, based on three successive approximations, is shown to be approximately as economical as the use of a process of appropriate higher order. Other ways of deriving a process of higher order from those of lower order include the use of iterated functions and of linear combinations of several low-order processes. All processes discussed in the paper are summarized in a table which also gives the number of arithmetic operations required for each. This information alone is not sufficient, however, to determine which one of the many formulas is most efficient in a given problem. F. L. Alt, USA

1259. **Freytag, H., Numerical compensation of set of measuring curves** (in German), *Ing.-Arch.* **22**, 3, 194–202, 1954.

Engineering information concerning a function of two independent variables is frequently presented in graphical form by choosing one variable to be a parameter assuming a constant value while measuring the effect of the other variable at b points. This paper presents a compensation procedure for use when a reversal of the roles of parameter and variable yields a second set of curves which does not coincide with the first set. This is likely to happen for flat curves or if the accuracy of measurement is different for the two cases. The author suggests a Gaussian method of least squares with a suitably chosen weight factor. Normally this would require the solution of ab equations. The principal result of the paper is to present the corrected values of the dependent variable as simple sums of ab terms, each term the product of two factors which may be obtained from formulas and tables given. These formulas and tables could be extended beyond the case $a = b = 5$ without excessive difficulty.

W. M. Stone, USA

1260. **Williams, J. D., The compleat strategyst,** New York, Toronto, London, McGraw-Hill Book Co., Inc., 1954, xiii + 234 pp. $4.75.

It is indeed a rare event when a mathematical or physical field is presented in lay or popular language to an aware and expectant public within 10 years of publication of the first scholarly book in the field. With the publication of "The compleat strategyst" such an event is a fait accompli; the field of scientific endeavor is, of course, the theory of games. From beginning to end, the book is as delightful and entertaining as it is informative. The author claims that the book is a "primer on game theory, for home study" and that no mathematics beyond arithmetic is required to understand it. The reviewer feels that the claims are justified. The author begins by introducing the subject (which is principally two-person zero sum games) and defining in very simple terms the language of game theory. The second chapter is devoted to two-strategy games and explains in lucid detail how one defines and solves the game problem. The "formalism" (or rather what passes for it) is broken up by using delightfully illustrated (by Charles Satterfield) sample problems to demonstrate the methods.

A typical problem, that of Portia's suitor, is drawn from "The Merchant of Venice." In order to win Portia, the suitor must select one of three jeweled casks. If he selects the correct one he wins Portia and a sizable dowry; if he fails he must, under the rules of the game, remain a bachelor for life. The game-theory analysis produces this solution: don't play the game (or with Portia) unless you love Portia at least twice as much as you hate the prospect of lifelong bachelorhood.

The later chapters discuss multiple strategy games (2×3, $2 \times n$, 3×3, $3 \times n$, $n \times n$) in the same refreshing manner. Each chapter contains a list of problems to be solved by the reader (the answers are included in the back; no peeking).

While the presentation is simple, author is completely honest in admitting the present limitations of game theory. The reviewer recommends the book to all who are interested in learning about a fascinating and relatively new field and to those who are in positions which constantly require decision making.

E. Koenigsberg, USA

1261. **Doob, J. L., Stochastic processes,** New York, John Wiley & Sons, Inc.; London, Chapman & Hall, Ltd., 1953, x + 654 pp. $10.

In this book one finds a rigorous and systematic account of an important branch of probability theory. No other book in English (nor for that matter in any language) treats some of these topics. In trying to write a book which meets the highest mathematical standards, the author has created a work which contains a mine of information for those willing to expend the required effort digging and exploring the terrain. There are many rich seams in this mine, but none are on the surface. The material in this book is extremely relevant to many problems in

communication theory, where one wishes to make best predictions or estimates when signals are contaminated by noise. Of interest to theoretical physicists is the author's treatment of Brownian motion, Poisson processes, diffusion equations, and associated Markov processes. Of particular interest to statisticians is the author's treatment of martingales. The notion of a martingale is motivated by intuitive ideas of what constitutes a fair gambling game. The author develops a theory which solves not only the original problem but also casts light on many fundamental topics in statistics, such as the likelihood ratio test and sequential analysis.

The table of contents is as follows: I. Introduction and probability background; II. Definition of a stochastic process—principal classes; III. Processes with mutually independent random variables; IV. Processes with mutually uncorrelated or orthogonal random variables; V. Markov processes—discrete parameter; VI. Markov processes—continuous parameter; VII. Martingales; VIII. Processes with independent increments; IX. Processes with orthogonal increments; X. Stationary processes—discrete parameter; XI. Stationary processes—continuous parameter; XII. Linear least square prediction—stationary (wide sense) processes. Supplement, Appendix, Bibliography, and Index.

In summary, let me say that this book, written by a distinguished scholar, will have a great impact on future developments in stochastic processes. These developments will, in turn, have their impact on applied science. B. Epstein, USA

1262. Burrows, W. H., Direct construction of nomographs from tables, *Indust. Engng. Chem.* **47,** 1, 33–37, Jan. 1955.

1263. Boesch, W., Use of normal mechanical calculator for calculation with complex numbers (in German), *ZAMP* **5,** 4, 341–344, 1954.

Mechanics (Dynamics, Statics, Kinematics)

(See also Revs. 1270, 1279, 1294, 1304)

1264. Ward, E. E., The calculation of transients in dynamical systems, *Proc. Camb. phil. Soc.* **50,** part 1, 49–59, Jan. 1954.

Paper describes procedure based on method of F. Tricomi [*R.C. Accad. Lincei* (6) **21,** 235, 1935] for obtaining the inverse of a given Laplace transform $F_1(s)$ of a transient without finding its poles. This is done by arranging $F_1(s)$ in the form $(\sum_{n=0}^{\infty} a_n\sigma^n)$ $(1 - \sigma)/2b$, where $\sigma = (s - b)/(s + b)$, from which the inverse transform is found as $F(t) = \sum_{n=0}^{\infty} a_nB_n(bt)$, where $B_n(bt)$ is the nth orthonormal Laguerre function of the argument $2bt$. Numerical comparisons with exponential inverse transforms are made for transforms having from quadratic to sixth-power polynomial denominators. Analysis of coefficients a_n discloses conditions for rapid convergence of Laguerre series and leads to proposed rule for best choice of real constant b. Author concludes that, provided poles of transform are not too widely spaced, method is practical alternative to use of partial fractions.

L. Maunder, USA

1265. Kuz'min, P. A., On the theory of stability of motion (in Russian), *Prikl. Mat. Mekh.* **18,** 1, 125–127, Jan./Feb. 1954.

Author gives two theorems related to the second method of Lyapunov for determination of stability of motion.

E. Leimanis, Canada

1266. Lebedev, A. A., On the problem of stability of motion over a finite time interval (in Russian), *Prikl. Mat. Mekh.* **18,** 1, 75–94, Jan./Feb. 1954.

Let [1] $\dot{x} = X(x,t)$, $X(0,t) = 0$ be a system of differential equations. Consider a motion of [1] corresponding to finite initial perturbations and subject to finite permanent perturbations. Using a method of G. V. Kamenkov [title source, **17,** 5, 529–540, Sept./Oct. 1953], author obtains conditions for stability of the unperturbed motion. In addition, a method is given for determination of a time interval over which the unperturbed motion is stable. E. Leimanis, Canada

1267. Joy, T. J. P., and Hartley, D. C., Tyre characteristics as applicable to vehicle stability problems, *Proc. Instn. mech. Engrs. Auto. Div.* **6,** 113–122, 1953/1954.

Authors give results of extensive tests carried out on "stability machine" consisting of driving dynamometer coupled to steel drum, tire on test being driven on drum by another dynamometer. Tire can run on drum at slip angles of up to 12 deg at speed of 36 to 125 mph and under a load of up to 2400 lb. Authors consider test limitations and accuracy and publish comprehensive curves of effect of load on cornering force, self-aligning torque and load, speed and cornering force on losses due to tires; also curves on effect of inflation pressure, braking, traction, rim diameter, section width, number of plies and effect of wear on self-aligning torque, and the effect of inflation, braking, traction, rim width and diameter, section width and wear on cornering force and effect of latter on power consumption. The interpretation of rig tests in terms of road performance is also considered and attention is drawn to the effect of various factors on transient conditions. The treatment is mainly a nonmathematical recital of actual rig and road test results. Authors stress importance of co-operation between tire and vehicle designers in early stages. The value of paper is enhanced by discussions of others, notably V. E. Gough.

In view of relative paucity of reliable information on tire characteristics and the importance attached to this matter, this is a most timely and welcome paper which should be carefully studied by vehicle designers when considering stability problems.

J. L. Koffman, England

1268. Koenigsberg, E., and Johnson, V. R., Metallic friction and lubrication by laminar solids, *Mech. Engng., N. Y.* **77,** 2, 141–147, Feb. 1955.

Servomechanisms, Governors, Gyroscopics

(See also Revs. 1449, 1471, 1472, 1532)

1269. Grammel, R., The self-excited unsymmetrical gyroscope (in German), *Ing.-Arch.* **22,** 2, 73–97, 1954.

Paper deals with a generalization of the Poinsot motions. Author defines a system of this kind as a "self-excited gyro" when it is acted on by a vector moment **M** arising from internal reactions. Different cases are possible according to whether **M** is fixed within the ellipsoid of inertia (notation here $\mathbf{M}_f$), moves ($\mathbf{M}_m$), or its modulus changes with time ($\mathbf{M}_t$). Likewise, for the angular velocity vector **O**, similar characteristics exist ($\mathbf{O}_f$, $\mathbf{O}_m$, $\mathbf{O}_t$). Author observes that Euler's equations generally are used to determine **M** for a given **O** (generally, $\mathbf{O}_f$), whereas he proposes to attack the inverse problem, which raises some difficulty inasmuch as **O** enters nonlinearly in these equations. This imposes the use of a nonlinear procedure (the iteration method of approximations).

According to this plan and with the above notations (of the

reviewer) the paper can be abstracted as follows: Section 2 deals with $\mathbf{M}_f$ on a principal axis of E, and the iteration is used up to the third approximation. A similar calculation is carried out in section 3 with $\mathbf{M}_f$ slightly off the principal axis. The neighborhood within which this can be done is ascertained from the convergence of approximations. Section 4 combines the results of sections 2 and 3. Owing to the linearization of the differential equations, the superposition of solutions is assumed which permits using the iteration method. Two kinds of asymptotic solutions are ascertained; for one the vector $\mathbf{O}$ approaches one of the principal axes and, for the other, it approaches some fixed direction in E. Section 5 considers the case: $\mathbf{M}_f$ on the principal axis and $\mathbf{O}_m$ on an arbitrary direction initially. Author shows that in this case there exists an exact solution in the form of Jacobi's functions *cn*, *sn* and *dn*. In section 6 is considered the case: $\mathbf{M}_f$ on the middle axis of E while $\mathbf{O}_m$ is constrained to the plane containing this axis. It is shown that the domain of existence of solutions is contained between the Poinsot limit planes; section 7 differs from 6 in that $\mathbf{M}_f$ has also components along two other axes of E. The last three sections deal with particular cases. Section 8 investigates $\mathbf{O}_{fl}$ with the $\mathbf{M}_f$ excitation; section 9, $\mathbf{O}_{fl}$ with $\mathbf{M}_{fl}$ excitation; and, finally, section 10, $\mathbf{O}_{fl}$ with $\mathbf{M}_m$ excitation.

Summing up, this paper generalizes the Poinsot motions (under no forces) to a variety of new motions resulting from the various moments due to internal reactions. N. Minorsky, France

1270. **Slomyanskiĭ, G. A., Integration of the equations of motion of a symmetric astatic gyroscope** (in Russian), *Prikl. Mat. Mekh.* **17**, 4, 411–422, July/Aug. 1953.

Consider a symmetric astatic gyroscope. Let $OXYZ$ be a fixed right-hand orthogonal trihedral whose Z-axis is directed upward along the axis of the outer gimbal bearings. Let $Oxyz$ be a moving trihedral with the z-axis along the axis of the rotor and with the x-axis along the axis of the inner gimbal bearings. The position of the z-axis is determined by two angles α and β, where β is the angle between the z-axis and its projection on the XY-plane, and α is the angle between this projection and the Y-axis. The basic problem is to express these angles α, β as functions of the time t. If the components of a torque applied are M_x, M_y, $M_z = 0$, then the differential equations which govern the angles α, β are

$$\ddot{\alpha}\cos\beta - 2\dot{\alpha}\dot{\beta}\sin\beta + n\dot{\beta} = n^2 m_y$$

$$\ddot{\beta} - n\dot{\alpha}\cos\beta + \dot{\alpha}\sin\beta\cos\beta = -n^2 m_x \qquad [1]$$

where $n = H/A$, $m_x = M_x/An^2$, $m_y = M_y/An^2$, and where $H(=\text{const})$ and A denote the component of the kinetic moment along the z-axis and the equatorial moment of inertia of the gyroscope, respectively.

The general solution of [1] by quadratures is given and discussed in the following cases: (1) $M_x = M_y = 0$; (2) $M_x = \text{const}$, $M_y = 0$; (3) subcase of regular precession for $M_x = \text{const}$, $M_y = 0$; (4) $M_x = M_x(\beta)$, $M_y = 0$. E. Leimanis, Canada

1271. Richardson, K. I. T., The gyroscope applied, New York, Philosophical Library, 1954, 384 pp. $15.

1272. **Bühler, H., A practical method for determining the transient response of an automatic control system from the frequency response** (in German), *ZAMP* **5**, 5, 420–425, 1954.

Author treats the problem of deriving the transient response of a feedback system from the transfer function $F(j\omega)$ of the closed loop. This problem was treated by A. Leonhard [AMR **7**, Rev. 3470], and others. Following Leonhard, author writes the transient response in terms of a Fourier integral in the real $U(\omega)$ or imaginary parts $V(\omega)$ of $F(j\omega)$. The functions $[U(\omega) - F(0)]$ or $V(\omega)/\omega$ are approximated by simple auxiliary functions. A table enables the analyst to go from these approximations to functions from which the transient can be readily constructed. The transition from frequency response to transient response is thus facilitated. R. Oldenburger, USA

1273. **Paynter, H. M., How to analyze control systems graphically,** *Control Engng.* **2**, 2, 30–35, Feb. 1955.

The method uses actual operating characteristics to get quantitative results. It handles limits, backlash, curvilinearity, nonsymmetrical response, and distributed effects.

Although it stresses only one application—flow and level control in a storage tank—this restriction of subject matter does not limit the scope or applicability of the methods or concepts.

From author's summary

1274. **Adamson, D., and Lyons, D. J., Note on the dynamic characteristics of servo-tab systems of control,** *Aero. Res. Counc. Lond. Rep. Mem.* no. 2853, 12 pp., Apr. 1948, published 1954.

Generalized curves have been constructed from which estimates can be made of those dynamic characteristics of the servo-tab-type of control which are of chief interest to the designer, viz., (1) the magnitude of the first overshoot of the main flying control beyond its equilibrium position, (2) the lag of the main control surface behind the tab movement, (3) the damping of the main control surface oscillation, (4) the angular velocity possessed by the main control when it first passes through its equilibrium position.

The characteristics evaluated for two specific cases, a 50,000-lb and a 300,000-lb aircraft, indicate no special problems to the designer or pilot except with regard to overshoot of the control at low flying speeds. Elastic stops are considered to be the most promising solution to this. From authors' summary

1275. **Macmillan, R. H., Analysis of regulating systems with particular reference to speed control,** *Trans. ASME* **76**, 8, 1237–1243, Nov. 1954.

See AMR **7**, Rev. 3121.

1276. **Thayer, W. J., and Muzzey, C. L., Flight control servo development,** *Cornell aero. Lab. Rep.* CAL-63, 62 pp., July 954.

Chronological development of position servo for actuating flight control surface of high-speed airplane. Inadequate preliminary assumptions required more accurate mathematical model of hydraulic-mechanical elements of system. Subsequently, servo stiffness requirements force a reversal of earlier decision, based on stability considerations, to replace flow control valve with pressure control valve. Improvements in the servo amplifier, plus velocity feedback, yield a control system performance, verified by test, equal to ten cps second-order system and resolution equal to two milliradians of control surface motion. Standard inverse Nyquist plot techniques were employed for servo analysis. D. H. Price, USA

Vibrations, Balancing

(See also Revs. 1265, 1468)

1277. Heins, A. E., editor; Churchill, R. V., Reissner, E., and Taub, A. H., editorial committee, "Wave motion and vibration theory," Proc. Symp. appl. Math., vol. V, New York, Toronto, London, McGraw-Hill Book Co., Inc., 1954, 169 pp. $7.

Book contains fifteen independent papers presented at the 1952 Symposium:

C. C. Lin, Hydrodynamic stability—Careful, critical survey of problem of determining Reynolds number (R) — wave number (α) stability loci of steady flows with respect to small disturbances therefrom. Following the introduction, paper is divided into three approximately equal parts: (a) Discussion of plane Poiseuille flow is based primarily on the work of Heisenberg (1924) and the author (1944), with later contributions by Tollmien (1947) and Wasow (1953); Pekeris' (1948) contradictory (to Heisenberg-Lin) results that plane Poiseuille flow always is stable are cited as incorrect, a conclusion confirmed by Thomas (1952) and Tatsumi (1952). (b) Nearly parallel, two-dimensional flows such as boundary layers and jets, with particular reference to recent studies of the compressible boundary layer by Dunn and the author (1952). (c) The limiting case of infinite αR, with particular reference to the behavior of inner and outer friction layers and regions.

S. Chandrasekhar, Examples of the instability of fluid motion in the presence of a magnetic field—Survey of author's contributions to title subject, with particular reference to Rayleigh problem [*Sci. Papers*, vol. 6, p. 432] of thermal instability of horizontal layer of incompressible fluid and Taylor problem [*Phil. Trans. roy. Soc. Lond.* (*A*) **223**, 289, 1923] of stability of viscous flow between concentric, rotating cylinders of approximately equal radius. Original problems mathematically identical, but addition of magnetic field and assumption of electrical conductivity exerts much stronger stabilizing effect on latter.

P. R. Garabedian, On free surface flows—Surveys recent research of Lewy, Schiffer, and author on axially symmetric cavitational flow as an extremal problem, first suggested by Riabouchinsky [*C. R. Acad. Sci. Paris* **185**, 840, 1927], leading to existence theorem.

W. Bleakney, Review of significant observations on the Mach reflection of shock waves—Brief survey with 32 references to pertinent, recent (1945–1952) experimental and theoretical papers.

N. W. McLachlan, On a nonlinear differential equation in hydraulics—See AMR **8**, Rev. 139.

Harold Levine, Acoustic radiation pressure on a circular disk—See AMR **8**, Rev. 279.

W. Magnus, Infinite matrices associated with a diffraction problem (Abstract)—Abstract of paper published elsewhere [*Quart. appl. Math.* **11**, 77, 1953].

A. E. Heins and Herman Feshbach, On the coupling of two half planes—Problem of plane harmonic wave incident on plane $y = 0$ that is described acoustically by different complex admittances for $x > 0$ and $x < 0$ is formulated as Wiener-Hopf integral equation. Fourier transform of solution is obtained by usual methods of function theory. Far field is determined by asymptotic development.

G. F. Carrier and W. H. Munk, On the diffusion of tides into permeable rock—Water-level fluctuations resulting from diffusion of tidal disturbances are calculated using as a model a semi-infinite ocean acting on either a horizontal shelf or vertical cliff bounding a semi-infinite porous medium. Resulting boundary-value problem solved by Wiener-Hopf technique. Results for amplitude of fluctuation exhibit good agreement with limited experimental data on irrigation wells in Hawaiian Islands, but agreement with observed phase lags is poor.

J. J. Stoker, Some remarks on radiation conditions—Difficulties connected with determination of appropriate radiation conditions on steady-state, traveling-wave problems in infinite medium when disturbing boundary extend to infinity are discussed. Initial value problem for surface-gravity waves created by oscillating pressure on infinite liquid is solved, and it is shown that the asymptotic solution for large time *does* satisfy Sommerfeld, radiation condition. Author suggests general procedure of modifying boundaries in finite part of domain to obtain solvable, initial value problem and then applying radiation condition found for large time to original, steady-state problem.

E. W. Montroll and J. M. Greenberg, On the theory of scattering of the plane-waves by soft obstacle—Recent developments by van de Hulst, Hart, Glauber, and the authors on scattering by obstacles in which wave length inside scatterer approximates that of incident wave but where the range of the scatterer is large enough to render the Rayleigh-Gans-Born approximation inadequate. Results are of interest chiefly in connection with problems of basic physics and chemistry but also should find application in acoustics.

A. Weinstein, On the wave equation and the equation of Euler-Poisson—A general solution to the Cauchy problem

$$\sum_{i=1}^{m} (\partial^2 u/\partial x_i^2) = (\partial^2 u/\partial t^2) + kt^{-1}(\partial u/\partial t) \qquad [1]$$

$$u = f(x_i)\ (\partial u/\partial t) = 0 \text{ at } t = 0 \qquad [2]$$

is obtained by using Hadamard's method of descent and an extension thereof to generalize the known result for $k = m - 1$ [R. Courant and D. Hilbert, "Methoden der mathematischen physik," vol. II, J. Springer, Berlin, 1937, p. 411]. The solution for negative k is not unique. Author shows that for the classical wave equation ($k = 0$) a sufficient condition for the existence of a Huygens principle is that f have not less than $\frac{1}{2}(m + 3)$ derivatives, and states that the value $\frac{1}{2}(m + 1)$ and proof thereof given by Courant-Hilbert (loc. cit., p. 399 ff) are incorrect.

E. H. Lee, Wave propagation in helical compression springs—Author's summary states: ". . . a theory of spring surges including coil closure is formulated, both for inelastic and elastic coil-impact conditions. Problems of the former type closely resemble certain problems in the propagation of plastic waves in compression, and the mathematical techniques developed for that work can be utilized. Perfectly elastic coil-on-coil impact demands a quite different type of mathematical analysis associated with the propagation of force doublets along the elastic spring, resulting in intermittent pulses of compression. Some simple boundary-value problems are analyzed, with an indication of the generalization to more complex problems. The accuracy to be expected from the type of analysis suggested is discussed."

S. Lefschetz, On Liénard's differential equation—Behavior of solution to $\ddot{x} + F'(x)\dot{x} + x = 0$, outside limit cycle, is discussed for suitably restricted $F(x)$. Author also discusses corresponding forced oscillation problem.

R. J. Duffin and A. Schild, The effect of small constraints on natural vibrations—Result that increase of square of angular frequency of normal mode due to small constraint is equal to corresponding increase of potential energy of unconstrained (and suitably normalized) system under static application of constraint is stated and proof sketched. Result is applied to string and clamped plate; in particular, author shows that vibration of lowest frequency for clamped plate *can* have nodal line in contrast to Rayleigh's opposite result for membrane.

J. W. Miles, USA

1278. Biezeno, C. B., and Grammel, R., Engineering dynamics. Vol. III. Steam engines (translated from German by Winter, E. F., and Havemann, H. A.), London and Glasgow, Blackie & Son, Ltd., 1954, xi + 264 pp. 40s.

1279. Biezeno, C. B., and Grammel, R., Engineering dynamics. Vol. IV. Internal-combustion engines (translated from German by White, M. P.), London & Glasgow, Blackie & Son, Ltd., 1954, xii + 282 pp. 50s.

These two textbooks represent English translations of the 1953 version of "Technische Dynamik," originally published in German in 1939.

They represent an academic approach to a group of problems related to steam turbine and internal-combustion engines. The material is based largely on the classic German literature of the 1920's and 1930's, to which Professor Grammel made notable contributions.

The character of the two books is essentially analytic. Descriptions of physical phenomena and experimental observations have been deliberately omitted. Thus the books are directed not so much toward practicing engineers as toward those who desire to obtain an extensive theoretical background of the topics selected.

Vol. III is entirely devoted to rotating disks, turbine blades, and critical speeds of rotors. Vol. IV deals with inertia forces, power smoothing, and torsional vibrations in reciprocating engines of many configurations.

As is to be expected, most references relate to articles and books which appeared in Germany many years ago. Vol. III makes no reference to any American contributions. Vol. IV contains one reference to R. E. Root's "Dynamics of engine and shaft" (1932). R. P. Kroon, USA

1280. **Bishop, R. E. D., The analysis and synthesis of vibrating systems,** *J. roy. aero. Soc.* **58,** 526, 703–719, Oct. 1954.

Paper discusses use of concept of "receptance" (mechanical admittance) in vibration analyses of conservative systems with finite numbers of degrees of freedom. One particular advantage cited is that complicated systems can be synthesized from simpler subsystems in an orderly manner. Paper is written from elementary standpoint and contains many examples. Useful tables of receptances and formulas for synthesizing complex systems are included. J. M. Hedgepeth, USA

1281. **Bogdanoff, J. L., Goldberg, J. E., and Lo, H., Application of Volterra linear integral equations to the numerical solution of vibration problems. Part II,** *J. aero. Sci.* **21,** 6, 383–388, 403, June 1954.

Paper presents results which are a further application of a method previously reported by authors [AMR **7,** Rev. 2394]. A numerical method is given for the approximate solution of boundary-value problems. Method consists in replacing the differential equation for the problem by a linear Volterra integral equation and solving the integral equation numerically, subject to the boundary conditions. The examples considered have variable coefficients in the differential equation and pertain to the torsional and lateral vibrations of thin beams of variable section.
P. G. Jones, USA

1282. **Mitropol'skiĭ, Yu. A., Forced vibrations in nonlinear systems passing through resonance** (in Russian), *Inzhener. Sbornik, Akad. Nauk SSSR* **15,** 89–98, 1953.

Author points out that while the passage through resonance of forced vibrations can be considered in accordance with Lewis [*Trans. ASME* **54,** p. 253], this method does not apply for nonlinear systems. Practical requirements demand analysis of passage through resonance of nonlinear systems with simultaneous change of not only forcing frequency but also mass, stiffness, or forcing amplitude. Analysis is carried out on basis of successive approximations suggested by Krilov and Bogolyubov.

Two cases are considered in detail: (1) Vibrator subject to nonlinear damping force $F = cx + dx^3$ and subjected to constant amplitude, variable frequency oscillation; (2) undamped nonlinear system subject to variable frequency and amplitude oscillations.

Reviewer considers paper of interest in connection with clarification of the general structure of nonlinear dynamics.
J. L. Koffman, England

1283. **Shimanov, S. N., Theory of vibrating quasilinear systems** (in Russian), *Prikl. Mat. Mekh.* **18,** 2, 155–162, Mar./Apr. 1954.

Periodical solutions of differential equations

$$(dx_s/dt) = a_{s1}x_1 + \ldots\ldots + a_{sn}x_n + \mu f_s(t, x_1, \ldots .x_n)$$

are obtained by method of successive approximation, given by I. G. Malkin [title source, **14,** 2, 1950]. The convergency of this approximation is proved, using two lemmas newly established without assumption of the Cauchy-Lipschitz condition on partial derivative of f_s, which is needed in Malkin's proof.
M. Kataoka, Japan

1284. **Stellmacher, K. L., Forced nonlinear vibrations with high forcing frequency and their stability** (in German), *ZAMM* **34,** 3, 105–119, Mar. 1954.

Aim of the paper is to study the behavior of nonlinear oscillators in the case of nonlinear excitation of high frequency. For this purpose, periodic solutions of certain differential equations of the second order are constructed, and the stability of these solutions is investigated. The periodic solutions have certain points of bifurcation, that represent, in this case, general limits of stability.
From author's summary by H. G. Cohen, USA

1285. **Kauderer, H., Determination of force-deflection curve for nonlinear vibrator from dynamic measurements** (in German), *Ing.-Arch.* **22,** 3, 215–226, 1954.

Assume that nonlinear vibration follows law $a\ddot{q} + R(q) = 0$ where a is mass coefficient, $R(q)$ is force corresponding to deflection q. Required to find $R(q)$, given period as function of amplitude for free vibration. Most of paper is devoted to laborious series methods for solving equation deduced from above by use of Abel's integral equation. Mathematical examples and checks are discussed but no experimental results.
B. Noble, England

1286. **Kenney, J. T., Jr., Steady-state vibrations of beam on elastic foundation for moving load,** *J. appl. Mech.* **21,** 4, 359–364, Dec. 1954.

Paper presents an analytic solution and resonance diagrams for a constant-velocity moving load on a beam on an elastic foundation, including the effect of viscous damping. The limiting cases of no damping and critical damping are investigated. The possible velocities for the propagation of free bending waves are found and their relation to the critical velocity of the beam is studied.
From author's summary by W. M. Whyburn, USA

1287. **Bondar', N. G., Solution of dynamic problems of rod systems by means of electric models** (in Russian), *Inzhener. Sbornik, Akad. Nauk SSSR* **16,** 87–108, 1953.

Paper is based mainly on previous work by Tetel'baum and Gutenmaher (1949) on the solution of differential equations of beams with discrete masses by means of electric models. These consist of $2n$ oscillatory circuits (n number of degrees of freedom) with condensers and coils in parallel, connected by condensers, if magnetic fluxes or the corresponding time integrals of tension are taken as generalized coordinates (second kind of electromechanical analogies).

Conditions of similitude and the choice of parameters for electric models are discussed first under the assumption that the initial values of coordinates and their time derivatives are zero. Experimental results for frequencies of free vibrations in electric models of an arch with clamped ends and of a beam on two sup-

ports are from 4 to 10% below the theoretical values. Modifications of electric models are then discussed if viscous friction must be taken into account or if other initial conditions are prescribed.

Vibrations of arches and frames with displacements in two directions can be dealt with by connecting two electric models of the above type by means of condensers and resistors. Cause of systematic discrepancies between the results in electric models and in the corresponding structures are examined and, in the last section, electric models for a beam and an arch are described, where the generalized coordinates are represented by charges in electrical circuits (first kind of electromechanical analogies).

A. Kuhelj, Yugoslavia

1288. Stanišic, M. M., Free vibration of a rectangular plate with damping considered, *Quart. appl. Math.* **12,** 4, 361–367, Jan. 1955.

Author treats problem of finding damped frequencies of free vibration of a rectangular plate with fixed edges by Galerkin's method. This problem is significant when treating plates of materials having considerable internal friction. An equation is derived for the damped frequency in terms of the natural frequency and a damping coefficient.

Paper contains tables that are helpful in finding natural frequency. In heading of Table 2, however, it appears to the reviewer that the quantity "l" in front of the integral sign should be replaced by the quantity "$1/l$." Heading of Table 3 refers to a damped square plate, while actually the quantities in the table do not depend on the damping. Table 4 gives a comparison between natural frequencies, obtained by equating damping to zero, and those obtained previously by Dana Young. The agreement is excellent.

N. O. Myklestad, USA

1289. Breslavskiĭ, V. E., Vibrations of cylindrical shells (in Russian), *Inzhener. Sbornik, Akad. Nauk SSSR* **16,** 109–118, 1953.

Author gives results of theoretical and experimental investigations of a cylindrical shell. In the case of axisymmetrical free vibrations, the solution of the equations as given by Flügge is simplified by assuming that the longitudinal displacements and Poisson's ratio equal zero. The equation is thus reduced to a form of the equation for bending of a beam on elastic foundation. Frequencies for both simply supported and built-in edges of the shell are calculated. Analogous results are also obtained using the strain-energy method. In the case of flexural vibration, author simplifies the differential equations as given by Flügge and obtains an expression for the frequency with an error of only 2–3% for simply supported shells for a small number of waves. Another method is given for shells with rigid supports. Experimental results show fairly close agreement with the frequencies predicted by the analysis.

M. Maletz, USA

1290. Waller, Mary D., Symmetry of vibrating square membrane, *Proc. phys. Soc. Lond.* (*B*) **67,** 420B, part 12, 895–898, Dec. 1954.

1291. Dockstader E. A., Swiger, W. F., and Ireland, E., Resonant vibration of steel stacks, *Proc. Amer. Soc. civ. Engrs.*, **80,** Separ. no. 541, 27 pp., Nov. 1954.

Authors describe wind effects on the steel stacks of the Moss Landing Steam Plant, Monterey Bay, about 100 miles south of San Francisco, which caused serious vibrations at low wind velocities. Cause of phenomena and corrective measures taken in connection with stack design are detailed. Based on aerodynamic principles, it is shown that stacks can be free of induced vortex vibrations if made so stiff that their fundamental frequency as a cantilever, or twice their fundamental frequency as a ring, are equal to or more than the frequency of eddy formation for a wind velocity of 70 mph, computed for a Strouhal number of 0.22. The magnitude of lateral forces induced by eddy formation is still considered to be uncertain, the uncertainty of the coefficient of lift varying from 0.65 to 1.71. It is also thought that roughness of surface contributes to considerable reduction in the vortex-induced vibration, evident from high stability of lap-jointed riveted stacks as against those fabricated by welding, where the surface is much smoother. This paper, along with a companion paper (see following review), forms an admirable exposition of the current state of affairs prevailing in the realm of vibration of steel stacks.

S. K. Ghaswala, India

1292. Dickey, W. L., and Woodruff, G. B., The vibration of steel stacks, *Proc. Amer. Soc. civ. Engrs.*, **80,** Separ. no. 540, 20 pp., Nov. 1954.

Absence of data regarding magnitude of forces produced by periodic vortex discharge, or the damping properties of stacks in absorbing the energy resulting from these periodic forces, has prompted authors to accumulate such data and evolve tentative conclusions.

Detailed examination of source of vibrations, damping forces, and vibration frequencies is made and a description given of model tests undertaken. Vibration characteristics of a number of steel stacks in existence or under construction, such as those at the Contra Costa Steam Plant, Oleum Steam Plant, etc., are enumerated. After having collected necessary data, authors discuss their findings and evolve conclusions for the design. Their suggestions which are worth noting are:

(1) Highest probable wind velocities should be assumed. Eliminating tornados from consideration, velocities of 120 mph in Florida hurricanes and slightly less along the Atlantic and Gulf coasts occur. With these exceptions, a safe value of 80 mph can be assumed for the rest of locations in continental United States.

(2) Increasing the diameter of stacks so that their natural frequencies are higher than that of the vortexes prevents undue vibrations. For stacks higher than 150 ft, this becomes uneconomical.

(3) Natural frequency of the stack can be increased by designing it as a frustrum of a cone, thereby increasing its moment of inertia throughout.

(4) Rigid bracing of stacks also reduces vibration. Optimum location is at a point $^2/_3$ of the height of the stack.

Since design of stacks is a major financial undertaking in an industrial concern, the several uncertainties still prevailing in its realms must be carefully investigated. Among these are the drag coefficients for cylinders in the range of Reynolds number of 3 to 10 million; drag coefficient of vibrating cylinders and the corresponding lateral coefficients of force; establishment of the definite nature of self-excited vibrations; and evolution of practical methods for elimination of the shedding of periodic vortexes.

Paper forms a notable contribution to the literature on vibration of steel stacks and forms a steppingstone for further investigations into this unchartered realm. (See also preceding review.)

S. K. Ghaswala, India

1293. Adkins, J. E., and Gent, A. N., Load-deflexion relations of rubber bush mountings, *Brit. J. appl. Phys.* **5,** 10, 354–358, Oct. 1954.

Paper reports (very) approximate load-deflection relationships for hollow rubber circular cylinders supported on inner and outer cylindrical surfaces. Supports analytical results by static tests. Agreement is good for symmetric deflections, poor otherwise. Indicates plane strain assumption very poor for l/d ratio as large as 2.

R. Plunkett, USA

1294. **Cicala, P., On the determination of the action of a shock absorber** (in Spanish), *Comun. Inform. Escuela super. Aerotecn. Córdoba*, 1–2, 25 pp., 1954.

The general equations for the shock-absorber system are simplified with suitable hypotheses and reduced to a form suited to step-by-step calculations (interpolation by finite differences calculus). Author considers with particular attention the initial and final phases of the stroke. Several methods for numerical integration, with significant numerical examples, are illustrated. G. Sestini, Italy

1295. **Yorgiadis, A., Damping capacity of materials,** *Prod. Engng.* **25,** 11, 164–170, Nov. 1954.

After a concise survey of the present state of known facts about internal damping of solid materials, author gives table with empirical values of specific damping capacity of 12 materials (damping capacity defined as energy absorbed per unit of volume of material per cycle of stress). Table is valid for tension compression and for shear modes of stress. The data are applied in a diagram concerning the amplification of the stresses in a bar carrying a mass which is in resonance in axial direction. To calculate quickly resonance stresses in nonuniformly stressed members (in tension-compression, bending, and torsion), author presents numerical values of damping ratios and so-called resonance excitation ratio for a number of geometrical configurations of members and loading systems.

Article contains many useful data for mechanical constructors. M. Kuipers, Holland

1296. **Nicolaisen, J., The reduction of vibration,** *Engineering*, **178,** 4631, 556–558, Oct. 1954.

1297. **Parmakian, J., Vibration of the Grand Coulee pump-discharge lines,** *Trans. ASME* **76,** 5, 783–788, July 1954.

See AMR **7,** Rev. 1525.

1298. **Waller, Mary D., Note on surface vibrations of a circumscribed liquid,** *Proc. phys. Soc. Lond. (B)* **67,** 420B, part 12, p. 899, Dec. 1954.

Wave Motion in Solids, Impact

(See also Rev. 1277)

1299. **Boley, B. A., and Chao, C.-C., Impact on pinjointed trusses,** *Proc. Amer. Soc. civ. Engrs.* **81,** Separ. no. 605, 38 pp., Jan. 1955.

Paper treats case of mass impacting on ideal truss, i.e., no energy loss and no bending in truss members, and no dispersion of stress waves. Problem is essentially one of keeping track of reflection and refraction of waves at joints. Equations and recommended procedures are given and a numerical example is worked out. G. W. Housner, USA

1300. **Adem, J., On the axially-symmetric steady wave propagation in elastic circular rods,** *Quart. appl. Math.* **12,** 3, 261–275, Oct. 1954.

An infinite rod with time-harmonic axial body force is examined. Radial and longitudinal displacements are derived in terms of real and complex roots of Pochhammer frequency equation. Due to rapid decay with distance the complex roots need only be considered near the origin. Two numerical examples for ultrasonic and low frequencies are given. The solution for a semi-infinite rod with prescribed end conditions is given.

R. N. Arnold, Scotland

1301. **Huth, J. H., and Cole, J. D., Impulsive loading on an elastic half-space,** *J. appl. Mech.* **21,** 3, 294–295, Sept. 1954.

Brief note considers the wave system resulting from a step loading on an elastic half-space. The stresses in the one-dimensional "head" (Region III) are given exactly. The maximum width of this head is $2r_0$, and its depth along the axis falls off like $1/z^2$ for large z. However, the magnitude of the stresses within the head remain constant. This and the abrupt drop behind indicate the one-dimensional head could be of considerable importance in spalling problems, but it appears to have been overlooked by investigators in this field. Integrals representing reflected waves can be obtained and treated by the same method.

From authors' summary

1302. **Calvert, N. G., Impact torsion experiments,** *Instn. mech. Engrs.*, 3–8, 2 plates, 1955.

Description of apparatus and calibration techniques. Test results on hollow specimens of as-rolled or normalized carbon steel (0.1, 0.2, and 0.3% carbon) at speeds ranging up to 4 radians per second are given and compared with results of static tests. Upper and lower yield points increase approximately linearly with the logarithm of the speed and there is a suggestion of a transition from static to impact conditions at about 0.1 radian per second. Maximum stresses revealed no systematic trend with strain rate. G. V. Smith, USA

1303. **Scott, E. J., Wave propagation in a visco-elastic medium,** *Quart. appl. Math.* **12,** 3, 300–306, Oct. 1954.

Paper considers propagation of longitudinal waves through a material the mechanical behavior of which can be represented by a series of Maxwell units joined in parallel. The case of an infinite slab, one face of which is suddenly accelerated to a constant velocity, is treated and the form of the general solution obtained by use of suitable Laplace transforms. The special case of a model consisting of two Maxwell units joined in parallel is then solved in detail and the results plotted of displacement-time and velocity-time curves for different layers in the slab.

H. Kolsky, England

Elasticity Theory

(See also Revs. 1302, 1303, 1325, 1352, 1354, 1362, 1368, 1376 1465, 1509)

1304. **Fairman, S., and Cutshall, C. S., Mechanics of materials,** New York, John Wiley & Sons, Inc.; London, Chapman & Hall, Ltd., 1953, x + 420 pp. $5.75.

This is another of an accumulating body of texts directed to meet the requirements of the typical introductory course in mechanics of materials for engineering students. The authors have made a presentation marked by its clarity and directness of approach.

There is little of novelty in the presentation. The classical arguments, standard procedures, and accepted sequences of treatment have been followed in almost all respects. This detracts from its interest to the expert or the teacher, but is probably completely desirable from the viewpoint of the engineering student.

The material is accompanied by many well-chosen and simple line drawings. There is a very large selection of problems, all with answers provided and many completely worked as examples. The area-moment method applied to beams, column-design theory, and methods of dealing with combined stresses are among the topics given particular attention.

Emphasis throughout is upon basic principles. It should meet the requirements of most engineering courses in this respect while remaining thoroughly teachable.

For a first edition, the presentation seems remarkably polished. Throughout it is apparent that, as the authors state, the book is a product of many years of experience in teaching in this field.

F. C. Hooper, Canada

1305. Mossakovskiĭ, V. I., and Zagubizhenko, P. A., On a mixed problem in the theory of elasticity for planes weakened by straight slits (in Russian), *Dokladi Akad. Nauk SSSR (N.S.)* **94,** 3, 409–412, Jan. 1954.

Considered is the equilibrium of an infinite elastic plate, weakened by a thin rectilinear slit and subjected to compressive forces, in the plane of the plate, which act at an angle to the direction of the slit. These forces will produce contact of the two opposite slit edges in the central portion of the slit. Neglecting friction along the contact, author solves this problem by employing the method of complex variables developed by N. I. Muskhelishvili.

G. Herrmann, USA

1306. Platrier, C., Characteristic function of state of stress in a given material (in French), *Ann. Ponts Chauss.* **123,** 6, 693–701, Nov./Dec. 1953.

Based on existence of isothermal potential, author expresses variation of internal energy per unit mass as differential of a function of six terms of deformation tensor of an infinitesimal transformation. This function depends on physical properties of material and is said to be characteristic.

Relationship between stresses and infinitesimal transformation in terms of this characteristic function is obtained. Included is author's statement of problem of evaluating stresses in a body under known inertia forces and surface tractions, when shape of body is known only before deformation.

E. G. Newman, USA

1307. Burmistrov, E. F., Stress concentration around certain types of oval apertures (in Russian), *Inzhener. Sbornik, Akad. Nauk SSSR* **17,** 199–202, 1953.

By method of Muskhelishvili, author computes stress on boundary of oval aperture in infinite plate subjected to tensile stress at infinity making angle α with oval axis. He computes same for oval cylindrical aperture with axis normal to axis of cantilever beam of constant cross section, shear being applied at free end.

T. C. Doyle, USA

1308. Nakanishi, F., Endurance limit under combined rotating bending and static tension, *Proc. 1st Japan nat. Congr. appl. Mech.*, 1951; Nat. Committee for Theor. appl. Mech., May 1952, 107–110.

For nonuniform stress distribution under static loading, two yield conditions are given, which are discussed for a round bar under combined bending and tension. Similar conditions are proposed for endurance limit. Experimental results obtained with specimen under combined rotating bending and static tension agree closely with calculated values.

H. Mussmann, Germany

1309. Sobey, A. J., Thermo-elastic similarity, *Aircr. Engng.* **24,** 307, 298–299, Sept. 1954.

1310. Schenker, L., and Martin, G., Analog computers applied to elastic-plastic systems, *Proc. Amer. Soc. civ. Engrs.* **80,** Separ. no. 528, 1–13, Oct. 1954.

A circuit is described by the use of which differential analog computers can be adapted to solve the equations of motion of systems incorporating springs with elastic-plastic resistance characteristics. The application of the method to a single-story structure is described and illustrated. The circuit can be used in conjunction with multi-degree-of-freedom systems with or without viscous damping. Interesting possibilities for further research are briefly discussed.

From authors' summary

Experimental Stress Analysis

(See also Rev. 1346)

1311. Kuipers, M., Numerical calculation of the end-effect of cylinders, used as measuring element in load-cells, *Appl. sci. Res. (A)* **4,** 5/6, 337–360, 1954.

Author relates force on a load cell to strains obtained by reading resistance-type strain gages arranged axially on the body of a cylindrical shell. Two things seem wrong with such a system. One is that individual differences can be great and that it is wise to depend on a calibration curve for each load cell determined in an accurate testing machine rather than on calculations from strain readings. The other is that some strain gages will ordinarily be placed in a circumferential direction and the gages connected in a bridge circuit at the load cell, which would increase the complexities of any calculations such as those made by the author. In brief, the paper seems more theoretical than practical.

W. C. Johnson, Jr., USA

1312. Favre, H., and Schumann, W., Some recent applications of the pure optical method to the study of bent plates (in French), *Bull. tech. Suisse Rom.* **80,** 20, 305–313, Oct. 1954.

Paper is a report of three investigations made in Favre's laboratory at Zurich which was read at the First Inter. Coll. of photoelasticity and photoplasticity at Brussels, July 1954. Two of them have already been published [Gilg, B., "Experimental and theoretical investigations of thin plates," Publ. no. 5, Lab. Photoelast. École Polytechn. Fédérale, Zurich, 1952 (in German); Favre, H., and Schumann, W., "Experimental study of the moments in a bent oblique plate as a function of the angle formed by the sides," *Bull Soc. Française Mécan.* no. 9, 1953 (in French)]. The third is an experimental check of a theoretical investigation by W. Schumann [AMR **7,** Rev. 3148] dealing with Saint Venant's principle in plate bending. This one is to be published later.

E. Mönch, Germany

1313. Schlechte, F. R., and Rosecrans, R., Experimental stress analysis of stiffened cylinders with cutouts, *NACA TN* 3192, 87 pp., July 1954.

Paper is one of a series of three giving results of tests of a cylindrical semimonocoque shell 30 in. in diam by 9 ft in length, consisting of 24S-T aluminum-alloy skin 0.051 in. thick, 36 external $^3/_4 \times {}^3/_4 \times {}^3/_{32}$ angle stringers, and eight equally spaced 24S-T aluminum alloy Z-section rings. The rings were made of $^1/_8$-in. sheet and were 2 in. deep with 1-in. flanges. Previous papers [*NACA TN* 3039 and *TN* 3073] gave results of torsion tests and pure bending tests with no cutout and with cutouts successively enlarged from one bay in length by 30° in circumference to two bays in length by 130° in circumference. The present paper gives results for the specimen mounted as a cantilever and loaded by direct shear at the tip. Tests were made with no cutout, with the cutouts on the tension side, and with the cutouts centered on the neutral axis. Strain measurements made with wire strain gages near the cutout on the stringers, the skin, and the rings are given for each case and the stresses obtained are presented in tables and figures.

B. L. Wilson, USA

1314. Prentis, J. M., A combined strain and curvature gauge for use in testing concrete beams, *J. sci. Instrum.* **32,** 1, 19–21, Jan. 1955.

Rods, Beams, Cables, Machine Elements

(See also Revs. 1279, 1304, 1308, 1314, 1355, 1368)

1315. ten Bosch, M., Calculation of machine elements [Berechnung der Maschinenelemente], 3rd ed., Berlin, Springer-Verlag, 1953, x + 534 pp., 926 figs. DM 45.

The word "Lectures" in the title of previous editions has been changed to "Calculation" and the scope of the book has been extended accordingly. Also within the new scope, the other important aspects of machine elements, such as their production aspects, are still only briefly touched upon. The late author is well aware that in nearly all but the simplest cases one of the prerequisites for the calculational approach, namely, knowledge of the forces actually applied (including their variations or, say, time spectrum), has not yet been satisfactorily achieved. He felt that, in many textbooks on machine elements, simplification, by specialization, of calculational methods had gone so far as to cause them to fail in problems as yet insufficiently explored in practice. Accordingly, neither rules of thumb nor mere schemes of calculation are to be found in present book. [All in all, it would appear that author, like the classic master of machine elements, Leonardo da Vinci, favored the philosophy: Captain "theory" and soldier "practice" cannot very well do without each other and, although it may in all too many cases march in the rear, theory remains the captain.]

It is characteristic of author's approach that the text on the machine elements proper is preceded by a fairly extensive summary (covering more than a quarter of the entire text) of basic cases from the theory of strength, including thermal stresses. But nothing much is said about theory of plasticity; limit analysis and design are not treated at all.

Other branches of applied mechanics are included in the chapters on the appropriate machine elements. For instance, fluid dynamics is treated under sliding bearings and pipe lines, vibrations under shafting, and heat transfer under gears and sliding bearings. Chapters are devoted to: *Fastenings:* usual topics of rivets, keys, etc. Section on welds is, in view of their present-day importance, rather brief. *Shafting:* including shaft couplings and crankshafts; chapter ends by discussing critical rotational speeds. *Sliding bearings:* author makes interesting contributions of his own to theory of hydrodynamic lubrication, including comparison between some theoretical and experimental results. Although the art of selecting bearing materials, especially those for dynamic loading, is only just emerging from its empirical stage and therefore perhaps did not fit into author's scheme, the omission of information on the subject is to be regretted. *Rolling bearings:* well-trodden paths are followed. The book would have been even more valuable if some light had been shed on choice between rolling and sliding bearings.

Friction drives: including friction wheels, belts, hoisting ropes, clutches, and brakes. Chapter contains interesting but not fully convincing dimensional analysis of bending-fatigue strength of wire ropes.

Gears: comprising toothed gears for parallel and nonparallel shafts, epicyclic gears, and chain drives. "Specific sliding" is still treated as representative of a type of tooth wear (unspecified) that would be proportional to the amount of frictional energy expanded per unit tooth face area. The treatment of the heating of gears is not up to date in that there is no discussion on the flash temperatures that may give rise to the critical and increasingly important type of tooth wear, scoring, or galling. A more serious objection is that, although formulas for calculating gears for pitting are adequately developed, insufficient empirical data are given to enable reader to design gears from this point of view. Admittedly, this and several other shortcomings can be overcome by self-study of relevant references in the extensive bibliography that lists publications not only in German but also a fair proportion in English.

Theory of mechanisms: After a general introduction dealing mainly with the quadric chain, a topic that is missing from most books on machine elements, the connecting rod/crank mechanism, piston rods, and crossheads are discussed more widely. Chapter then proceeds to starting and stopping characteristics of machines, and ends by considering temperature rise of machinery such as gears, clutches, etc., both in continuous and intermittent operation, and how they are affected by both the generation and the dissipation of the frictional heat.

Pipe lines: metric pipe standards; calculation of flanges. Calculation of pipe lines based on theory and experimental data of flow and flow resistance, relating only to steady-flow conditions but including the effects of branching of pipe lines. Chapter ends with contact seals (including piston rings) and labyrinths.

For several of the afore-mentioned machine elements, more specialized and sometimes even more modern books are available, but this does not detract from the chief merit of the book, which is that future writers of books on machine elements can take example from it. It is a pity that author has not lived to round off his book and see it translated into other languages.

H. Blok, Holland

1316. Schiebel, A., Gears. Vol. I, Spur and bevel gears [Zahnräder, Bd. I. Stirn- und Kegelräder mit geraden Zähnen], 4th rev. ed. (revised by Lindner, W.), Berlin, Springer-Verlag, 1954, vi + 122 pp., 183 figs. DM 18.

Lindner has revised Professor Schiebel's well-known 1934 book on gears. Chap. A of part 1 deals with basic definitions and relations for conjugate gear-tooth action. Chap. B gives a thorough treatment of the kinematics of spur and internal gears with cycloidal and involute tooth forms, and formulas are deduced for calculating deflections and stresses in gear teeth,due to bending, shear, and contact loading. There is also a discussion of frictional forces, heat generation, and wear. Finally, a theory for vibrations in gear teeth is presented.

Part 2 is devoted to applications. Chap. A treats bevel gears with cycloidal, spherical involute, and octoid gear-tooth forms. Chap. B considers noncircular gear wheels and chap. C deals with planetary gear systems. Chap. D describes some standardized rack forms and gives an interesting discussion on optimum choice of tooth correction for different properties or combination of properties. Chaps. E and G contain some practical hints for the designer, and chap. F gives a short account of the manufacture of gears.

The presentation of the kinematical relations is clear and the many drawings and graphical constructions are very useful. Unfortunately, some misprints occur in the text and the drawings.

Reviewer believes that methods for calculating deflections, strength, and frictional forces are not up to date. Formula for Herz' deflection is not in accordance with recent and stringent investigations by C. Weber and K. Banaschek [AMR **7,** Rev. 54]. Method adopted for calculating bending strength is due to Niemann [AMR **4,** Rev. 2850]. According to reviewer's experience, a more accurate method is proposed by T. J. Dolan and E. L. Broghamer [*Univ. Ill. Bull.* no. 31, 1942]. This method seems to be adopted in the United States [AMR **7,** Rev. 2100]. Notch-sensitivity factor is referred to as a material constant, although recent investigations have shown it to be dependent on geometrical factors as well [AMR **7,** Rev. 2100].

Frictional forces set up between gear profiles in contact are assumed to be proportional to velocity difference only. According to a recent thorough theoretical investigation by C. Weber and W. Thuss [AMR **6,** Rev. 2427], velocity sum can be just as important.

S. Sjöström, Sweden

1317. Wolf, A., The basic laws of planetary trains [Die Grundgesetze der Umlaufgetriebe] (Schriftenreihe Antriebstechnik, Heft 14), Braunschweig, Friedr. Vieweg & Sohn, 1954, 100 pp., 20 figs. DM 9.80.

This concise booklet gives a very complete discussion of the kinematics and power analysis of single and multiple planetary gear transmissions. Author derives general theory of planetary trains such that ordinary fixed-center gear drives represent a special case of general species. The thorough presentation of torque and power loss distributions in planetary trains is a particularly valuable contribution to the literature of gearing. Considerable use is made of symbolic notation to facilitate selection of proper parameters in design. A summary of important theorems and design criteria and a group of illustrative examples is appended.

Book should prove helpful in design of planetary trains; however, since the topic and the method of presentation are unique, most readers will require thorough indoctrination with terminology and basic technique before being able to use book as a ready design reference source. G. A. Nothmann, USA

1318. Hotchkiss, C., Jr., Flexible shafts, *Prod. Engng.* **26,** 2, 168–179, Feb. 1955.

1319. Meebold, R., Cables and their practical use [Die Drahtseile in der Praxis], 2nd rev. ed., Berlin, Springer-Verlag, 1953, vi + 108 pp., 121 figs. DM 12.

Book deals with construction and application of wire ropes. Under construction, following items are covered: Principal types of wire ropes; strand arrangements; strength and design of ropes; wire materials; ratio of wire to rope diameter; number of wires in strands and wire arrangements. Under application, the following items are covered: Life of wire ropes as affected by nature of service; methods of fastening rope ends; methods of binding ropes; wear, loosening, untwisting, and distortion in ropes; types of wire-rope failures; corrosion in wire ropes and prevention of corrosion. A brief bibliography completes the book.

D. Kececioglu, USA

1320. Scanlan, R. H., Electrical resistance networks for beam and column problems, *J. aero. Sci.* **21,** 11, 787–789, Nov. 1954.

Malavard and Boscher, in a series of condensed notes, have exhibited the essential characteristics of a useful all-resistance electrical network which represents various two-dimensional fields. The fields may represent the potentials for stress or fluid flow or, for example, the deflection pattern of a plate or membrane. Their basic idea is briefly described.

From author's summary

1321. Odqvist, F. K. G., Theory of elastic rings with strong curvature (in German), *Ing.-Arch.* **22,** 2, 98–107, 1954.

Rings and beams (open rings) of strong curvature and any cross section are again investigated to allow more general systems of loading and to extend results obtained by R. Grammel. Any loading of the ends of a curved beam is described by superposition of six pairs of loads, given in a table. Two examples are calculated: the circular ring (a) loaded by any number of equal radial forces, or moments, equally spaced, and (b) with uniform load perpendicular to the plane of the ring which is supported, equally spaced. G. Sonntag, Germany

1322. Mikeladze, M. Sh., Bending of beams subjected to centrifugal forces (in Russian), *Inzhener. Sbornik, Akad. Nauk SSSR* **16,** 173–176, 1953.

A loaded cantilever rotating about a vertical axis is considered in this short paper. Deflections are modified by centrifugal forces caused by cantilever's own weight. Volterra integral equation of the second kind is formulated for the general problem. A solution in terms of power series is illustrated in a simple example (q = const). The elastic and the ultimate capacities of beams are discussed. E. P. Popov, USA

Plates, Disks, Shells, Membranes

(See also Revs. 1289, 1304, 1307, 1312, 1332, 1337, 1349, 1355, 1525)

1323. Fung, Y. C., and Wittrick, W. H., The anticlastic curvature of a strip with lateral thickness variation, *J. appl. Mech.* **21,** 4, 351–358, Dec. 1954.

Authors consider the distortion of the cross section of a thin strip of plate bent longitudinally into a circular arc. They consider a strip with a cambered double-wedge cross section. As the solution for the flat strip of constant thickness was long ago given by von Kármán, and as this has been extended by Ashwell to include the cambered strip, new ground is broken only by introduction of variable thickness. A number of interesting curves show the effect on the distortion of the cross section of varying the camber and the parameter λ, which is proportional to $b(Rt_0)^{1/2}$ (where $2b$ and t_0 stand for width and average thickness of strip and R is the radius of its arc). Reviewer considers term "boundary layer" misleading and would prefer "edge margin." D. Williams, England

1324. Müller, W., The deflection of rectangular plates deduced from the logarithms of the ϑ-functions by integration (in German), *ZAMM* **34,** 1/2, 12–18, Jan./Feb. 1954.

Author presents further results in the use of "theta" functions for plate problems and gives new series for the deflection of rectangular plates, obtained by integration of the logarithms of theta functions. [See AMR 6, Rev. 3699.]

Author has computed and tabulated the real and imaginary parts of these new functions and plotted contour diagrams. Application to cases of the continuous mushroom floor and to the simply supported rectangular plate with a point load is given. A. Burn, Australia

1325. Razletov, B. K., Determination of stress fields in a flat plate having an axisymmetric dent (in Russian), *Inzhener. Sbornik, Akad. Nauk SSSR* **17,** 29–42, 1953.

Infinitely large plate with an axially symmetrical dent subjected to in-plane tension is considered in the paper. The problem somewhat resembles the one of stress concentration around a circular hole. The shape of the dent is defined by $z = -z_0/(1 + kr^2)$ where z_0 is the depth of the dent and k is a parameter. The author uses basic equations in terms of complex variables for thin surfaces of revolution from V. V. Novozhilov's book "Theory of thin shells" (in Russian), 1951. An exact solution in terms of hypergeometric series and an approximate one are given for an axially symmetrical loading. The solution for plate loading varying with sine and cosine of 2ϕ is found approximately. The paper is concluded by a thorough discussion of stress distribution in a plate subjected to uniform tension in two directions, and in one direction and pure shear.

E. P. Popov, USA

1326. Bijlaard, P. P., Stresses from radial loads in cylindrical pressure vessels, *Welding J.* **33,** 12, 615s–623s, Dec. 1954.

Design information on deflections, bending moments, and membrane forces caused in cylindrical vessels by radial loads transmitted through various attachments.

From author's summary

1327. Krieger, S. W., Bending of plates bounded by conics and clamped, *J. appl. Mech.* **21,** 3, p. 296, Sept. 1954.

1328. Horne, M. R., Shells with zero bending stresses, *J. Mech. Phys. Solids* **2, 2,** 117–126, Jan. 1954.

The problem of finding special forms of shells which do not develop bending deformations when subjected to external forces is treated for shells of revolution. It is shown that for the case when the applied force is a uniform axial force, the condition of vanishing bending deformations can be simply formulated. From geometrical considerations, a differential equation of second order for the meridian curve is found, containing the thickness function and its first derivative. The possible forms of shells with variable and also with constant thickness are discussed.

H. Neuber, Germany

1329. Yoshimura, Y., Elasticity theory for parallelogram thin plates (in Japanese), *J. aero. Soc. Japan* **1,** 3, 6 pp., Oct. 1953.

The elasticity theory of parallelogram thin plates is developed by use of the oblique Cartesian coordinate system. The analysis leads to oblique coordinate expressions of the fundamental equations, i.e., the stress-strain and moment-curvature change relations, the equilibrium, and the compatibility conditions.

Application of the results to the swept wing is to be expected.

From author's summary

1330. Esslinger, Maria, Calculation of a cable winding drum (in German), *Stahlbau* **23,** 7, 150–157, July 1954.

For a drum under a uniform distributed radial load over part of the circular midsection, a solution for the maximum stresses in the shell and the rings is presented based on Flügge's bending theory for axisymmetrical shells. An approximate method is proposed which yields sclutions in a much shorter time. Tables are given, based on the last method, which may prove useful for the solution of drums under the same type of loading.

M. Botman, Holland

1331. Berger, E. R., Roots of the characteristic equation of a circular cylindrical tube (in German), *Ing.-Arch.* **22,** 3, 156–159, 1954.

Expressions are developed for the approximate roots of the characteristic equation for the bending of a cylindrical shell under end loads. Numerical examples presented show no appreciable improvement of accuracy over other approximate methods cited by author. H. G. Maier, USA

Buckling Problems

(See also Revs. 1304, 1320)

1332. Goodier, J. N., and Hsu, C. S., Nonsinusoidal buckling modes of sandwich plates, *J. aero. Sci.* **21,** 8, 525–532, Aug. 1954.

Paper examines the possibility of nonsinusoidal modes in wrinkling instability of sandwiches subject to end loads. This investigation, of considerable intrinsic and practical interest, is based on an idealized model in which the core is assumed to have zero stiffness when subject to displacements parallel to the faces, but finite direct and shear stiffness for deformations perpendicular to the faces. Such a special orthotropic model of the core, applied previously by Reissner and others to the analysis of bending and buckling of sandwich plates, permits an elegant and simple analysis and may, moreover, be justified on physical grounds for certain cores. The authors prove that, for pinned ends, the sinusoidal modes do not yield the lowest wrinkling modes. Thus, critical loads approximately half as great are obtained in antisymmetrical modes in which the wrinkling is restricted to the neighborhood of the loaded ends while the main body of the sandwich remains practically flat but is translated laterally. Paper discusses also the case with clamped ends.

A close analogy to the nonsinusoidal modes in sandwiches is shown to exist in long pin-ended columns connected to a floating elastic foundation with a rigid base. The latter problem was investigated by Rakersdorfer. J. H. Argyris, England

1333. Fung, Y. C., The static stability of a two-dimensional curved panel in a supersonic flow, with an application to panel flutter, *J. aero. Sci.* **21,** 8, 556–565, Aug. 1954.

Author used aerodynamic pressure based on linearized theory and included the nonlinear effects of the change of axial thrust due to panel deformation. Edges of the panel were taken to be hinged, one fixed in position and the other restrained by a spring. The von Kármán large-deflection equation, generalized to initially curved plates, was used. Method of solution was to express both initial and final deflection curves of the midsurface by Fourier sine series, retaining only a finite number of terms for an approximation. The critical dynamic pressure above which no static equilibrium is possible was determined. The stability of the possible equilibrium configurations was investigated by virtual work, leading to a lower critical dynamic pressure, as a function of the initial deflection curve, above which no *stable* static equilibrium is possible. This lower critical dynamic pressure was interpreted as an upper bound for the dynamic pressure at which panel flutter would occur.

Numerical results are given for initially flat and curved panels between rigid supports, with axial load below or equal to the Euler load for buckling. The most remarkable conclusion appears to be that the critical dynamic pressure tends to zero for a buckled panel with vanishing initial amplitude of buckling. Author states that previous investigations, without considering change of axial thrust due to deformation, had claimed a constant critical dynamic pressure regardless of initial amplitude of buckling. (To this reviewer, the main reason lies probably in the stability investigations, since linearized treatment should be legitimate for the limiting case of infinitesimal initial buckling.)

The significance of the new result to panels under thermal buckling is evident. Reviewer believes paper is a worthy contribution to the field. S. F. Shen, USA

1334. Mackey, S., An experimental investigation of the behaviour of mild steel compression members in light lattice frameworks, *Struct. Engr.* **32,** 7, 190–197, July 1954.

Results of 19 tests of compression members of a triangular framework are given. Tests included effect of end moments from gusset plates in contrast to pin-connected conditions, variations in sizes of members, and variations in orientation of unequal leg angles. Failure of the struts follows the usual elastoplastic theory. Yield loads and ultimate loads were found to be not necessarily synonymous, but to vary with slenderness ratio, shape factor, and eccentricity. Tests were undertaken to check on B.S.S. 449 recommendations. T. A. Hunter, USA

1335. Massonnet, Ch., Buckling experiments on girders with stiffened web (in French), *Publ. int. Assn. Bridge struct. Engng.* **14,** 125–186, 1954.

Experimental results of tests on two large welded girders with thin-walled webs and horizontal and vertical stiffeners. Work represents continuation of previous investigations [AMR 5,

Rev. 653; **7,** Revs. 3184, 3195]. Paper discusses effects of these stiffeners on postbuckling behavior of the girders, in view of the fact that stiffeners do not remain perfectly straight in practice in this regime. Empirical factors are presented for the calculation of their stiffnesses so that the stiffeners will remain almost straight up to the rupture point of the girder. Buckling factors of safety are discussed for girders with webs stiffened according to author's stiffness criteria. H. Lurie, USA

1336. Cox, H. L., Computation of initial buckling stress for sheet-stiffener combinations, *J. roy. aero. Soc.* **58,** 525, 634–638, Sept. 1954.

Purpose of paper is to illustrate the practical application of the method of analysis based on Royal Aeronautical Society Structures Data Sheets 02.01.28 to 37 to familiar problems in the computation of initial buckling stress for sheet-stiffener combinations. From author's summary

1337. Alumyae, N. A., Critical load of a long cylindrical shell in torsion (in Russian), *Prikl. Mat. Mekh.* **18,** 1, 27–34, Jan./Feb. 1954.

By mathematical analysis author shows that the critical load in a thin shell in torsion depends on two circumstances: either the deplantation of the middle surface of the contour is possible or it is not. It does not depend on the degree of fixity of the middle surface. Determining the critical load for the shells of long and medium length is confined to the integration of the fourth-order equations which would satisfy two boundary conditions on each of the middle surface contours.

First of the conditions is for shells with such boundary conditions that the normal displacement of the middle surface contour is not permitted. The second boundary condition depends on existence or nonexistence of the possibility of the deplantation of the middle surface contour. Variations in the remaining boundary conditions are not reflected on the magnitude of critical load in thin shells. Author's graph has one curve for determining the critical stress for conditions when the deplantation of the middle surface is possible and another curve for the conditions when the deplantation of the contour is not possible. For the shells within the range of medium length the above curves provide the same values for critical stresses as could be obtained from Donnell's formulas for shells in this range with fixed and freely supported ends.

Author refers to the following papers: Sturm, R. G., "Stability of thin cylindrical shells," *Proc. Amer. Soc. civ. Engrs.* **73,** 4, 471–495, Apr. 1947; Donnell, L. H., "Discussion of Sturm's papers," ibid., **73,** 10, 1549–1552, Oct. 1947. Author observes that the solutions in these papers satisfy some of the conditions but not all of them. Author remarks that Donnell considered the critical load to be independent of the degree of freedom of deplantation of the middle surface. V. A. Valey, USA

Joints and Joining Methods

(See also Revs. 1299, 1348, 1365)

1338. Baron, F., and Larson, E. W., Jr., Comparative behavior of bolted and riveted joints, *Proc. Amer. Soc. civ. Engrs.* **80,** Separ. no. 470, 19 pp., Aug. 1954.

Results of static and fatigue tests of double lap (butt) joints made with four or six hot-driven, hot-formed cold-driven, cold-formed and cold-driven rivets or high-strength bolts of $^3/_4$-in. diam and grip length from $1^3/_{16}$ in. to $3^1/_{16}$ in. and tension shear bearing ratios of from 1.00:0.75:1.50 to 1.00:1.26:1.83 in ASTM A7 steel are reported. Clamping stresses increased with grip length for hot-driven and decreased for cold-driven rivets. Alloy steel rivets to ASTM A195 developed appreciably greater clamping force than ASTM A141 rivets only for grip lengths 3 in. and longer. Average static joint efficiencies varied from lowest 70.8% for hot-driven A141 rivets in punched holes to 88% for hot-driven A195 rivets with t:s:b ratio 1.00:1.26:1.83. Although bolted joints had only been tightened to 28 ft lb instead of recommended 320 ft lb and first slip in static tests occurred at smaller shear stresses than for riveted joints, fatigue strength of bolted joints was zero to 28,000 psi for 2×10^6 cycles, whereas none of the riveted joints reached zero to 24,000 psi despite loss of clamping force in bolts, not due however to turning of nut. Fatigue strength of bolted joints, however, decreased with grip length, whereas fatigue strength of riveted joints increased with grip length. Alloy steel rivets are advantageous only for large grip lengths; cold-driven rivets give joints of much smaller fatigue strength because of low clamping force. Long cold-driven rivets will fail from bending fatigue. Joint slippage may be very large. No mention is made of type of washer used for bolted joint which, in view of paper by Carter, et al. (see following review), may be important. R. Weck, England

1339. Carter, J. W., Lenzen, K. H., and Wyly, L. T., Fatigue in riveted and bolted single lap joints, *Proc. Amer. Soc. civ. Engrs.* **80,** Separ. no. 469, 35 pp., Aug. 1954.

Failures of floor beam hangers in bridges at less than 1×10^6 cycles of heavy loading are reported by only one out of six railroads and only in single lap joints; hence special combination of circumstances may be responsible. If hypothesis is correct, that failures which do not occur at points of greatest computed stress are caused by stress concentrations due to bearing of rivets on plate edge of hole because of lost clamping force, the remedy is replacement of rivets by high-strength, nonbearing, high clamping force bolts.

Bearing of rivet after slip produces stress concentration factor 6, and this is the suggested cause of failures. Whereas fatigue strength in tension from zero to maximum is reduced from 30 ksi to 16 ksi by bored hole filled with fitted bolt and nut fingertight so that load is transmitted in shear and bearing, high tensile bolts in clearance holes tightened give 24 ksi on net area, and fatigue cracks no longer originate from edge of hole but edge of washer. Enormous reduction in fatigue strength of riveted joints results from using drift pin to correct misalignment of holes by eccentric hole deformation, but uniform enlargement of hole by drifting produces increase in fatigue strength due to uniform cold working and possibly compressive residual stresses.

Very high tensile stresses occur in immediate vicinity of edge of washer, which explains origin of fatigue failure in bolted joints with high clamping stress.

Experimental results quoted in paper seem to have been published before and, in reviewer's opinion, some of the theoretical considerations appear both abstruse and dubious. Authors speak of fatigue failure as "progressive brittle fracture," of "brittle state of stress" of "experimental determination of the stress concentrations by comparative fatigue tests within elastic limit as resting on proportionality between fatigue strength and stress concentration for values of the latter up to 3," though most of the experimental results they quote show that this is untrue. Paper is nevertheless very interesting and presents a great deal of useful information. R. Weck, England

1340. Mason, W. P., and Anderson, O. L., Stress systems in the solderless wrapped connection and their permanence, *Bell Syst. tech. J.* **33,** 5, 1093–1110, Sept. 1954.

The solderless wrapped connection is initially held together by the hoop stress in the wire which enters the connection as a

result of the tension put on the wire by the wrapping tool. Measurements made out to a time of 1.5 years at room temperature show that the tension has decreased to 70% of the one-day value (8000 lb per square inch) in this period. Two methods of extrapolation are discussed, both of which indicate that at least half of the initial one-day value will remain at the end of forty years at room temperature.

Another set of stress enters the connection as a function of time, namely, the diffusion forces produced by diffusion of the tin plating into the brass terminal and copper wire. A number of experiments are discussed which show that the activation energy of diffusion is materially reduced by the shearing stresses in the connection. Measurements at two temperatures, which allow extrapolation to room temperature, indicate that, at the end of two years, the force required to strip the wire from the terminal has increased by 5% over the initial value and that, at the end of forty years, the increase will be 20%. Support for these conclusions is furnished by tests on actual connections that have been in the field for one year and ten months, which show an increase of 5% in the stripping force even though the relaxed hoop stress is only 68% of the initial value. The increase, which is due to diffusion forces, can be made higher by using zinc, cadmium, or aluminum plating, and the fusion occurs in a shorter time.

From authors' summary

1341. Kihara, H., and Masubuchi, K., Theoretical studies on the residual welding stress, *Rep. Transport, tech. Res. Inst.* 6, 40 pp., June 1953.

In analogy to the vortex theory used in hydrodynamics, authors suggest determining the residual stress distribution by the introduction near the weld of a narrow region of incompatibility, the mathematical definition of which is given. Results will be published later. J. A. Haringx, Holland

Structures

(See also Revs. 1287, 1313, 1314, 1330, 1334, 1336, 1365, 1367, 1380, 1407, 1468)

1342. Livesley, R. K., and Charlton, T. M., The use of a digital computer with particular reference to the analysis of structures, *N. E. Cst. Instn. Engrs. Shipb. Trans.* **71,** part 2, 67–89, Dec. 1954.

Basic principles of electronic digital computer at Manchester University are described. Preparation of "programs" (instructions to the computer) is discussed. Application of digital computer to structural analysis is described. Particular example given involves simultaneous solution of equilibrium and compatibility equations by means of matrixes. Other structural applications, including vibration analysis and economical design, are discussed, as are the general problems of programming and future uses of computers.

From authors' summary by W. D. Jordan, USA

1343. Chagneau, A., and Fourgeaud, J., Study of test data of assemblies performed at the Experimental Center of Research and Development of the Technical Institute of Building and Public Works (in French), *Ann. Inst. tech. Bât. Trav. publics* **81,** 827–853, Sept. 1954.

Report consists of five parts: 1 "Tensile strength of plates with holes" (effect of drilling, punching, and punching and reaming on the net section strength). 2 "Stress distribution in angles working in tension or in compression." (There exists correlation between surface and mean stresses.) 3 and 4 "Tensile tests on assemblies in which rivets and bolts are loaded in shear and in tension" (deformation of the assemblies and calculation of the net section). 5 "Effect of prestressing (torquing) on final stress of bolts and rivets working in tension" (allowable stresses in torqued bolts and prestressed rivets).

J. Koziarski, USA

1344. Lusser, E., Simple calculation of 3-story frames loaded by lateral forces (in German), *Bautechnik* **31,** 8, p. 263, Aug. 1954.

Paper deals with 3-story (ground floor and 2 upper floors) 2-legged frames. Arrangement of the frame is symmetrical relative to its vertical median axis. Leg bases are built-in.

In the course of analysis the structure is bisected along its vertical line of symmetry. Vertical forces acting at the points of bisection are introduced as statically indeterminate quantities. For the latter, handy formulas are presented. Factors figuring in the latter are computable from geometrical data of the bars by the given formulas.

The formulas presented are applicable only to the afore-mentioned very special kind of structure. P. Csonka, Hungary

1345. Kuros, G. R., An electric experimental method for determination of bending moments of statically indeterminate frames (in German), *Bauingenieur* **29,** 1, 10–15, Jan. 1954.

Author demonstrates that the equations of a statically indeterminate bar system with rigid joints (Stabwerk, frame) are similar to the equations of an electrical conductor system. Hence results an interesting experimental method to determine the statically indeterminate bending moments, the bar system being replaced by an electrical conductor system.

The rigidity of a joint is composed of the rigidities of the adjoining bars; a similar relation exists for the ohmic resistance of a conductor system with branches connected in parallel. A moment acting on a joint can be replaced by a corresponding current intensity; the quantity of electricity passing through a branch conductor corresponds to the bending moment of a bar. The rotating angle of a joint can be determined from the voltage of the corresponding branch point of the conductor system.

The conductor system has to be built up according to the bar system, every partial system of parallel branch conductors corresponding to a joint, and the conductance (i. e., reciprocal values of resistance) of every branch conductor corresponding to the stiffness of a bar. The bending moment of a bar is determined by measuring the current intensity in the corresponding branch conductor; the rotation angle of a joint is determined by measuring the potential difference between both ends of the corresponding partial system.

Examples are given for simple bar systems. Author will deal with closed frames with movable joints in a future paper which will demonstrate the practical value of above method.

E. Seydel, Germany

1346. Clarke, N. W. B., Measuring loads in wires: two simple devices to ensure accuracy in prestressing, *Engineering* **177,** 4613, 812–815, June 1954.

Two simple methods for measuring total loads in prestressing wires are described: (1) Use of a very stiff double cantilever steel spring together with a dial gage to measure the deformation of the spring; (2) use of a lever loaded with known weights.

R. J. Hansen, USA

1347. Habel, A., Influence of reinforcement upon deflections in statically determinate reinforced-concrete and prestressed-concrete beams (in German), *Beton u. Stahlbetonb.* **49,** 8, 177–180, Aug. 1954.

Author considers deflections of simply supported beams of rein-

forced concrete and prestressed concrete. Deflections separately discussed and formulated are those due to long-time loading, shrinkage, and prestressing. J. Michalos, USA

1348. Choquet, A., Krivobok, V. N., and Welter, G., Effects of prestressing on fatigue strength of spot-welded stainless steels, *Welding J.* **33,** 10, 509s–523s, Oct. 1954.

Prestressing by hydrostatic means, compression, tension, and peening can be used to increase the fatigue strength of spot-welded joints. From authors' summary

1349. Duecy, G. P., and Hutsell, J. L., One-piece reinforced plastic forms for assembly line production of thin-shell concrete roof sections, *J. Amer. Concr. Inst.* **26,** 1, 89–92, Sept. 1954.

1350. Mühe, L., Simplified calculation of reinforced-concrete slab gridworks supported on two sides (in German), *Beton u. Stahlbetonb.* **49,** 8, 180–185, Aug. 1954.

Under certain simplifying assumptions, an exact solution is obtained for slabs with longitudinal beams and cross beams when supported along two sides. Particular cases of the exact solution are considered. An approximate solution of the simplified theory is presented and a numerical solution is obtained for a slab gridwork with three main beams and one cross beam. J. Michalos, USA

1351. Menze, D. G., Comparing investigations on reinforced concrete and steel piles (in German), *Beton u. Stahlbetonb.* **49,** 4, 79–88, Apr. 1954.

Steel and reinforced-concrete piles are driven by hammering to the fine and medium sand layer containing a small amount of fine gravel at the depth of about 10m through a sand layer and a thin clayey sand layer. It is observed from the hammering and bearing tests conducted that both kinds of pile have the same practical value under the same assumptions, contrary to the current opinion that the steel piles are superior with respect to bearing capacity. T. Mogami, Japan

1352. Parkes, E. W., Wings under repeated thermal stress, *Aircr. Engng.* **26,** 310, 402–406, Dec. 1954.

Author considers effect of cyclic variation of temperature on web and skin which represents segment of wing. Provided elastic limits are not exceeded after shakedown, the wing is safe. If limits are exceeded, collapse can occur, (1) web yielding alternatively in tension or compression, or (2) after changes in curvature of wing due to upper skin yielding in compression, lower in tension. D. R. Bland, England

1353. Terner, E., Some remarks on the structural analysis of swept wings, *Aircr. Engng.* **24,** 307, 288–291, Sept. 1954.

Problem of stress analysis of swept wings has been approached in different ways. Here a method is briefly surveyed in which swept structures are treated as orthotropic sandwich plates of varying thickness; the resulting nonlinear partial differential equation is linearized by suitable assumptions. Thus differential bending, flexure-torsion coupling, etc., can be treated with ease, and no virtual elastic axis is needed. Functions derived are regarded as two-dimensional analogs of the well-known concepts of one-dimensional engineers' beam theory. From author's summary

1354. Hovell, P. B., The stress distribution in a swept-back box-beam with perpendicular ribs, *Aero. Res. Counc. Lond. Rep. Mem.* no. 2837, 18 pp., Dec. 1950, published 1954.

A solution is obtained for the distribution of internal load in a sweptback box beam of rectangular cross section under any system of external loading. The theory, based upon strain energy, is considered exact when the ribs are perpendicular to the spars and when the spanwise bending loads are taken by the spar booms.

The general solution for encastré root conditions is given. Extensions of the method to cover root flexibility and cutouts in the top or bottom skins are discussed.

A numerical example of a simple two-spar box is investigated for a range of sweepback angle of 0 deg to 40 deg for an encastré root condition. The analysis shows that appreciable redistributions of load in the box, compared with the unswept box, are obtained when either torque or bending moment is applied to the beam. From author's summary

1355. Östlund, L., Lateral stability of bridge arches braced with transverse bars, *Trans. roy. Inst. Technol. Stockholm.* no. 84, 123 pp., 1954.

Book contains the results of theoretical and experimental studies carried on since 1944 in the department of structural and bridge engineering of the Royal Institute of Technology, Stockholm, under assistance of S. Sjöström, G. Wästlund, and S. V. Bergström. The main purpose is the study of various factors affecting critical loading and deflections caused by lateral loads: Flexural rigidities of transverse stiffening members and torsional rigidity of the arches; the rise of the arches; the number of transverse stiffeners; rigid decks below or above the arches.

Following conclusions are made: (1) Smaller torsional rigidity of the arches requires greater flexural rigidity of the transverse members. (2) The effect of torsional rigidity on critical load increases with the ratio of rise to span, especially in antisymmetrical buckling. (3) If the deck is below the arches the lateral forces act in direction opposite to the deflections and produce stabilizing effect, in similar way as a beam on elastic supports; in case of a deck above the arches the lateral forces have the same direction as the deflections, thus the decrease of the critical load is considerable. Six tests are described confirming theoretical investigations. J. J. Polivka, USA

1356. Stucky, A., Some problems in connection with the foundation of large dams (in French), *Bull. tech. Suisse Rom.* **80,** 21, 22; 317–325, 329–336, Oct. 1954.

1357. Yan, H. T., Bloom-base allowance in the design of pile caps, *Civ. Engng. Lond.* **49,** 575, 576; 493–495, 622–623, May, June 1954.

The assumptions of the method for bloom-base allowance used by the author in developing his method are not new; however, they have been neglected for a number of years. The criteria used are reasonable and rational and result in a substantial economy in reinforcement as compared with the methods currently in use in the United States.

Any designers responsible for pile caps for individual column footings will find their time well spent if they will investigate this method. It is based on tying the tops of piles in such a way as to resist thrust from the base-plate compression. K. W. Hendrickson, USA

1358. Stephenson, H. K., and Cloninger, K., Jr., Method of converting heavy motor vehicle loads into equivalent design loads on the basis of maximum shears, *Tex. Engng. Exp. Sta. Bull.* 131, 192 pp., July 1953.

The maximum stresses produced by heavy motor-vehicle types and loadings, on simple span bridges of various lengths, provide the means for comparing the stress-producing characteristics of any given vehicle with those of another. They also

provide a common unit of measure by which any given vehicle can be converted into some convenient or arbitrary equivalent loading, such as an equivalent H truck loading, an equivalent H-S truck loading, or an equivalent concentrated load.

The rating of heavy vehicle loads in terms of equivalent H truck loadings or any other convenient standardized loads can be accomplished by evaluating some maximum stress effect (moment, shear, or floor-beam reaction) on a simple span of given length, and then finding the gross weight required on the standard vehicle (or other standard loading) on the given span to produce the same effect.

Tables and charts are provided for the rating of most any type of heavy vehicle, ordinarily encountered in highway traffic, in terms of standardized equivalent loads. For convenience, the tables are prepared for first converting all vehicles into equivalent H truck loadings, which can then be converted into any of the other equivalent loadings given in Table 10.1 and Fig. 10.1 as may be desired.

The frequency distributions of equivalent H truck loadings and equivalent concentrated loads as given in parts III and IV, respectively, should prove to be of something more than passing interest. These distributions are sufficiently regular to yield practical answers to many questions concerning stress repetitions of various intensities. From authors' summary

Rheology (Plastic, Viscoplastic Flow)

(See also Revs. 1268, 1303, 1365, 1370)

1359. Velasco de Pando, M., Plasticity. New theory and applications [Plasticidad (Neuva teoria y aplicaciones)], Madrid, Patronato de Publicaciones de la Escuela Especial de Ingenieros Industriales, 1954, xvi + 256 pp. 130 ptas.

This treatise deals with the yielding at normal temperatures of solids stressed above their elastic limit, as primarily represented by ductile metals with a sharp demarcation between elastic and plastic behavior. Brittle, plastic, and highly elastic bodies are special conditions.

A consistent theory is derived, based on Stüssi's tests of simultaneous compression, torsion, and internal pressure on tubes, which yielded the conclusions that Poisson's ratio is the same in the elastic and plastic regions, and that cylindrical anisotropy is produced in the plastic region. Von Mises' criterion of plasticity is also accepted.

The new theory does not generally disagree significantly from other current theories, but is claimed to agree better with actual facts. C. F. Bonilla, USA

1360. Colonnetti, G., An attempt at generalization of the classical theory of elastic equilibrium (in French), *J. Math. pures appl.* **33,** 3, 187–199, July/Sept. 1954.

The essence of the paper lies in the derivation of several reciprocal theorems, analogous to the classical Betti theorem, for the case of a body undergoing small inelastic deformations.

H. Deresiewicz, USA

1361. Grigor'ev, A. S., Load-carrying capacity of thick flat plastic rings (in Russian), *Inzhener. Sbornik, Akad. Nauk SSSR* **16,** 177–182, 1953.

Author treats the problem on the assumption of constant tangential stresses by the method of limit analysis. Several cases of practical interest are solved, namely: (1) Built-in outer edge symmetrically loaded across the ring; same uniformly loaded all over and carrying another uniformly distributed load on the inner edge; (2) simple supported ring with loads both on the edges and on the surface distributed according to some law of proportionality. For the benefit of the practical designer, graphs are given showing the carrying load capacity and the corresponding stress for different ratios of the inner and outer radius. M. Maletz, USA

1362. Swann, W. F. G., Shear modulus and viscosity relations in plastic materials, *J. Franklin Inst.* **259,** 1, 11–16, Jan. 1955.

If the shear modulus and viscosity are functions of the frequency, the simple apparently linear viscoelastic equation is really nonlinear. In some experimental investigations, the rate of change of strain is equivalent to a frequency. Mathematical equations are derived showing what conditions will fulfill this condition. L. Nielsen, USA

1363. Bleakney, H. H., An evaluation of the recovery theory of creep, *Canad. J. Technol.* **33,** 1, 56–66, Jan. 1955.

The recovery theory of creep was defined by Bailey in 1926 as the balance of the rate of production of strain-hardening by distortion and its removal by thermal action. Three main objections have been raised, as follows: (1) The observation that creep-rupture tests made with light loads frequently reveal lower ductility than similar tests made with heavier loads is inconsistent with the recovery theory. (2) The equicohesive temperature concept is inconsistent with the recovery theory. (3) The experimental evidence for stress relaxation across grain boundaries as presented by Kê is inconsistent with the recovery theory. In this paper, evidence is presented to show that the phenomenon of creep-rupture embrittlement is not necessarily inconsistent with the recovery theory; that the equicohesive temperature concept may be without validity; and that Kê's conclusions are not substantiated by the evidence. It is suggested that the opposing influences of strain-hardening and thermal softening, modified by factors introduced by metallurgical instabilities, are the fundamental verities of creep.

From author's summary

1364. Ecker, R., Static and dynamic deformation properties of rubber vulcanizates and other high polymers (in German), *Schweiz. Arch.* **20,** 9, 291–304, Sept. 1954.

Data in graphical form are presented on dynamic modulus, damping factor, static modulus, 1-hr creep, permanent set, shore hardness, rebound, tear resistance, tensile strength, breaking elongation, and force-elongation relationships of eight materials, mostly rubbers. Various temperature ranges, from −60 to 160 C. Frequency in dynamic tests: 17 cps in compression tests; 25 cps in elongation tests; mean elongation in the latter, 20 to 180%.

Dynamic modulus and damping factor are shown to be correlated, in a general way, with most of the other tests.

M. Mooney, USA

Failure, Mechanics of Solid State

(See also Revs. 1337, 1339, 1341, 1348, 1382)

1365. Osgood, W. R., edited by, Residual stresses in metals and metal construction, New York, Reinhold Publ. Corp., 1954, xii + 363 pp. $10.

Twenty-two contributors express their views on the role of residual stress on phenomena in rheological material. Whereas the most common occurrence of damaging residual stress is in welded structures, the first seven papers give case histories of fracture attributed to residual stress from this source. While

there is over-all agreement that residual stress is of paramount importance and that "welding sequence" can literally make or break a welded structure, the complexity of the subject does not permit a conclusive decision as to the exact role residual stress plays.

The next four papers are quantitative in nature and consider the effects of residual stress on the behavior of plastic materials. These are followed by relatively individual papers concerning microstresses originated by gas inclusions, effect of residual stress on impact resistance, fatigue strength, and general failure of engineering materials. The measurement and detection of residual stress are treated in the five concluding papers, giving a comprehensive treatment of the role of trepanning, resistance strain gages, and x-ray analysis.

The book concludes with an excellent summary compositing the present state of the art and ending with "Recommendations for research." It is reaffirmed that the conclusions drawn as one reads articles on the effects of residual stress require basic research on the fracture phenomenon to permit the establishment of a relationship between the variety of effects observed in welded structures.

The fact that flame-cut thick plates are exceptionally prone to spontaneous fracture requires one not only to consider the gross effects of residual stress caused by thermal properties but to investigate the metallurgical and physical changes occurring in the region adjacent to the cut. This fact is ably brought out in several of the papers and is re-emphasized in the summary.

The book contains an excellent bibliography and is a valuable source book. Recently the Ship Structures Committee has published "An evaluation of the mechanics of brittle fracture" by D. C. Drucker, which is excellent additional reading.

S. L. Levy, USA

1366. Calvert, N. G., Experiments on the effect of rate of testing on the criterion of failure of certain mild steels, *Instn. mech. Engrs.*, 9–12, 1955.

Torsional impact tests were carried out on mild steel (0.1, 0.2, and 0.3% carbon) while subjected to static axial tensile stress. Strain rates were such as to cause yielding in the range 0.02 to 0.001 sec.

Observed stresses were compared with those predicted by various criteria. With increased speed of testing, the yield criterion moved in a direction away from that of constant shear strain energy toward that of constant tensile stress. Maximum observed torsional stresses lay between the constant maximum shear stress and the constant maximum tensile stress and were unaffected by rate of straining within range investigated. Angles to fracture diminished progressively as axial tension increased and tended to be slightly diminished by increased speed.

G. V. Smith, USA

1367. Shaw, R. R., The level of safety achieved by periodic inspection for fatigue cracks, *J. roy. aero. Soc.* **58,** 526, 720–723, Oct. 1954.

A critical examination is presented of the hazard involved when a fatigue weakness is discovered in a type of aircraft which is in operational service, and the use of such aircraft as have not yet shown cracks is continued as before with periodic inspections of the suspected weak spot. This procedure has been followed on several occasions in the past few years, and author contends that there is a serious possibility of the development of a visible crack followed by application of a gust load large enough to cause the crack to propagate to complete failure, in the interim between periodic inspections.

Development of the argument is based on a number of assumptions regarding probability of various events, all of which, however, appear reasonable and justifiable. The analysis indicates that in some cases the aircraft may have to be restricted to flights of absurdly brief duration if a level of safety equivalent to that of the rational performance code of the ICAO is to be maintained.

P. E. Sandorff, USA

1368. Payne, L. E., On axially symmetric punch, crack and torsion problems, *J. Soc. indust. appl. Math.* **1,** 1, 53–71, Sept. 1953.

Classical elasticity equations formulated in cylindrical coordinates for displacement, generalized Hooke's law, and equilibrium stress equations are expressed in terms of potential function satisfying Laplace's equation, together with an associated function. (Author points out that usual biharmonic function for plane problems can be avoided by using simpler harmonic function.) He claims manner of solution is simpler than that of previous writers.

Reviewer notes that classical compatibility conditions are not examined.

K. H. Swainger, England

1369. Payne, L. E., On axially symmetric crack and punch problems for a medium with transverse isotropy, *Proc. Camb. phil. Soc.* **50,** par 3, 466–473, July 1954.

Author elaborates theory of preceding review to particular anisotropy and solutions as in title.

K. H. Swainger, England

1370. Gubkin, S. I., and Rapoport, L. A., On the nature of fracture in plastic deformations of metals (in Russian), *Doklady Akad. Nauk SSSR (N.S.)* **94,** 4, 685–688, Feb. 1954.

In the first part of this work, author discusses the fracture of alloys in triaxial compression. He assumes that fracture can be produced only by tensile stresses. Although formally tensile stresses cannot appear in this scheme of stresses, he considers that they could be introduced by the inhomogeneity of the structure or by external forces such as friction, deforming tools, etc. In these areas of inhomogeneity, plastic deformation appears first, and, under appropriate conditions, recrystallization and phase transformation takes place, which in turn can cause change of volume and rise of temperature. All these effects produce tensile stresses. These stresses could be large enough to produce microcracks and finally a fracture.

Experimental evidence is given supporting the concept of the areas of localized plastic deformation and, connected with them, microcracks.

In the conclusion, author attributes the formation of the areas of localized plastic deformation as a characteristic feature of all plastic deformation.

In reviewer's opinion, it is not obvious that the appearance of a new phase, accompanied by change of volume and rise of temperature, as well as recrystallization should introduce tensile stresses in the material.

Attributing the proposed mechanism to all metals as a general characteristic of plastic deformation seems to be not fully justified. Experimental evidence quoted by author refers to alloys with rather complex structures. It is not clear if pure metals and structures in which phase transformation does not occur are considered.

W. Sylwestrowicz, USA

1371. Hanstock, R. F., Fatigue phenomena in high-strength aluminum alloys, *J. Inst. Metals* **83,** 11–15, 1 plate, 1954–1955.

The increase in damping capacity that precedes fatigue failure of the aluminum alloys L65 and D.T.D. 683 is associated with precipitate instability. In the alloy D.T.D. 683, localized bands of precipitation have been found, and these are regions where fatigue cracks eventually form.

The localized effects of cyclic stressing do not seriously impair the static strength, but the fatigue strength depends on the magnitude of the stress required to initiate precipitation and on the strength of the over-precipitated regions.

An alloy that derives its high static strength from a controlled state of precipitation that is unstable under cyclic stressing will have a high ratio of static ultimate strength to fatigue strength.

From author's summary

1372. Hikata, A., The size effect in fatigue of notched steel specimens loaded under reversed direct stress, *Bull. Gov. mech. Lab., Tokyo* no. 2, 8 pp., 1954.

1373. Simonetti, G., Cylinder wear in medium and large bore diesel engines, with particular reference to the use of heavy fuel oils (in Italian), *Assoc. Tech. Automobile, Ricerche* no. 6, suppl. to no. 8, Aug. 1953, 436–449.

Experience with large FIAT diesels in maritime service running on heavy bunker fuels shows increased cylinder liner wear rates since World War II. This is attributed to the higher sulfur and Conradson carbon content of postwar bunker fuels. Liners made from a cast iron high in phosphorus gave the best wear results. Method for measuring liner wear and an empirical laboratory test for wear properties of fuels are described.

In reviewer's opinion, inadequate attention is given to the influence of the lubricant; in particular, alkaline lubricating oil additives, so effective in reducing wear due to fuel sulfur in smaller diesels, could well be applied to these large engines also.

A. G. Cattaneo, USA

1374. Deterding, J. H., and Dyson, A., Radioactive isotopes for measuring piston ring wear, *Engineer, Lond.* **198,** 5149, 442–445, Oct. 1954.

Since Harwell began to produce radioactive isotopes much work has been started to discover how best such materials can be used for technological research. Article describes the use of piston rings of normal composition irradiated in the Harwell pile for the determination of wear. The radioactive constituents are listed, safety precautions mentioned, and counting methods discussed. Some results are given. It is concluded that the method is particularly suitable for following wear in detail over short intervals of time, but less suitable for long-term investigations. From authors' summary

1375. Dearden, J., The wear of steel rails: a review of the factors involved, *Proc. Instn. civ. Engrs.* **3,** 3, part 2, 456–481, 3 plates, Oct. 1954.

A new instrument has been used to measure the wear of rails of different compositions and of rails situated in widely varying conditions of traffic and atmosphere. On straight or slightly curved track which is typical of most lines on British railways, atmospheric corrosion has been found to have such a dominant effect that it usually masks any difference in the rate of wear of different compositions in the same track. Sorbitic rails were more wear-resistant than normal rails of the same composition, but suffered from corrugation and shelling. No difference could be detected between acid-Bessemer and basic-open-hearth-steel rails of the same nominal composition, nor between high-carbon- and medium-manganese-steel rails.

Rails have been found to wear more rapidly in industrial than in rural atmospheres for the same traffic. The lowest wear per million axles was found in the dry clean atmosphere of the London tubes.

Annual wear is considered to be directly proportional not to the annual traffic but to the square root of the number of axles passing per annum, because of the influence of corrosion.

The profile and condition of the running surface have been closely examined and observations made which may help to explain the process of wear. From author's summary

Material Test Techniques

(See also Revs. 1346, 1374)

1376. Lequear, H. A., and Lubahn, J. D., Root conditions in a V-notch Charpy impact specimen, *Welding J.* **33,** 12, 585s–588s, Dec. 1954.

The maximum conventional strain (in percent) at the root of a V-notch Charpy impact specimen is about ten times the angular displacement (in degrees) between the two ends of the bent specimen. The biaxiality at the notch bottom rises rapidly from zero at the side faces of the specimen and reaches 0.48 at the midwidth. Average strain at the notch bottom measured over a gage length equal to the root radius is within 10% of the maximum. From authors' summary

1377. Puzak, P. P., Schuster, M. E., and Pellini, W. S., Applicability of Charpy test data, *Welding J.* **33,** 9, 433s–441s, Sept. 1954.

Service data have demonstrated that the initiation of brittle fractures in welded structures of semikilled and rimmed structural steels is possible only at temperatures such that the steel develops less than 10 ft-lb energy in Charpy V tests. Similarly, propagation is possible only at temperatures of less than Charpy V 20 ft-lb. Crack-starter tests demonstrate that these steels have essentially no ductility in the presence of a sharp crack at temperatures below the Charpy V 10 ft-lb transition; this accounts for fracture initiation in service. Similarly, these tests demonstrate that fracture propagation changes from easy to difficult at temperatures of approximately 20 ft-lb Charpy V energy, which is also in agreement with service.

Crack-starter tests of fully killed steels, for which no service experience is available, indicate that the critical fracture initiation and propagation temperature are related to higher values of Charpy V energy. These data are interpreted to signify that service data correlation based on the NSB ship fracture steels cannot be extended to steels of different types.

From authors' summary

1378. Krenchel, H., Treatment of tension test specimens for fixing in testing machine, *Amer. Soc. Test. Mat. Bull.* no. 200, 44–46, Sept. 1954.

Plastic coatings prevent slip of specimens held by jaws of testing machines in static and fatigue tests.

From author's summary

1379. Gangler, J. J., High-temperature testing techniques for brittle refractory materials, *J. Amer. ceram. Soc.* **37,** 9, 439–444, Sept. 1954.

The evaluation of brittle refractory materials calls for special techniques that are different from those normally used for ductile materials. Techniques have been developed at the NACA Lewis Flight Propulsion Laboratory to evaluate brittle materials as turbine blades in jet engines and in creep, stress rupture, and thermal shock. The type of equipment and the procedure for creep and stress-rupture testing are described. A parameter is given by which the thermal-shock resistance of brittle materials is related to their physical properties. A simple apparatus has been devised to verify experimentally conclusions given by this

parameter. Another apparatus is described that simulates the thermal-shock conditions encountered in a jet engine. The final testing of materials in a jet engine is described.

From author's summary

1380. Ruzek, J. M., Knudsen, K. E., Johnson, E. R., and Beedle, L. S., Welded portal frames tested to collapse, *Welding J.* **33,** 9, 469s–480s, Sept. 1954.

The testing apparatus, measurement techniques, and testing procedure for the investigation of the ultimate carrying capacity of welded portal frames are described. Two frames of uniform cross section (8WF40 and 8B13, respectively) were tested, the loading being carried through the plastic range to failure. Some typical results are given.

A method of providing lateral support to the frames and a simple device for measuring the change in curvature of structural members are presented. From authors' summary

1381. Romualdi, J. P., Chang, C.-L., and Peck, C. F., Jr., A fatigue testing machine for range of stress, *ASTM Bull.* no. 200, 39–43, Sept. 1954.

Paper describes fatigue-testing machine for concurrent application of tension and rotating-bending "capable of subjecting. . . specimens to range of stress from complete reversal to pure tension at speeds of 1800 rpm." Information on the design, construction, and calibration is included.

H. J. Grover, USA

1382. Hartman, A., and Rondeel, J. H., Static tests and fatigue tests on Redux-bonded built-up and solid light-alloy spar booms, *Nat. Luchtlab. Amsterdam Rap.* M.1936, 17 pp., Feb. 1954.

Three types of Redux-bonded spar booms were subjected to static tests and fatigue tests in compression and/or bending. For comparison, bending tests were also carried out on solid machined booms. Angle-section booms were manufactured either by preforming the individual sheets before bonding or by bonding in the flat condition followed by rubber press forming. More complicated sections were bonded from preformed sheets.

The tests results are given in tables and diagrams and the conclusions are listed. From authors' summary

1383. Winkler, F., Relation between bundle strength and strength of individual fibers or yarns (in German), *Faserforsch. u. Textiltech.* **5,** 9, 398–403, Sept. 1954.

From the distribution of breaking strengths for single fibers or yarns at a given test length, the distribution at other test lengths can be calculated by the theory of Peirce [*J. Text. Inst.* **17,** T355, 1926] or of Weibull [*Ingen.-VetenskAkad.* no. 151, Stockholm, 1939]. The theory is supposed to be applicable to bundle tests as well, with the total length taken as the product of the number of fibers or yarns times the test length. The theory is in good agreement with the author's experimental results on multiple lengths of cotton thread and on bundles of cotton threads and of acetate filaments. D. J. Montgomery, USA

1384. Förster, F., and Stambke, K., Theoretical and experimental principles underlying the eddy-current test method for nondestructive testing of material. III. Use of a coil through which the material under test passes (in German), *Z. Metallk.* **45,** 4, 166–179, Apr. 1954.

This method permits the determination of the conductivity as well as the diameter of rods, wires, etc. Magnitudes of conductivity as well as of diameter are indicated. The instrument consists of a primary and a secondary coil and associated electrical circuit. Separation of the effect of diameter change and conductivity change is made possible by measuring separately the real and imaginary components of the output voltage.

The instrument may be applied to the sorting of rods, wires, and pipes. It may also be used to find changes in conductivity when engineering structures are hardened; also to indicate diameter changes due to attacking corrosive agents. It may also find application in following changes in tensile test or fatigue test specimens, while the test is in progress.

Paper describes in detail the underlying mathematical and experimental approach. It does not give details of instrument design. R. O. Fehr, USA

1385. Förster, F., Theoretical and experimental principles underlying the eddy-current test method for nondestructive testing of material. IV. Quantitative determination of defects in engineering materials (in German), *Z. Metallk.* **45,** 4, 180–187, Apr. 1954.

The theory of the eddy-current method for nondestructive testing purposes has been thoroughly treated in previous papers of this series. These papers also contained the underlying mathematics. While mathematical methods may be applied to changes in diameter and conductivity, they cannot handle the cases where defects such as flaws are present. However, by means of model testing it is possible to gain this information. Indications of the instrument due to defects can be stated; or, vice versa, indications of the instrument may be interpreted in terms of shape, location, and size of defect.

The statement is made that defects which are geometrically similar give the same eddy-current effects and the same changes in the effective permeability when the ratio of applied frequency to a so-called "limit frequency" is kept constant. This limit frequency is a function only of diameter, conductivity, and permeability of the test piece. R. O. Fehr, USA

1386. Förster, F., and Breitfield, H., Theoretical and experimental principles underlying the eddy-current test method for nondestructive testing of material. V. Eddy current equipment for practical tasks in the field of nondestructive testing (in German), *Z. Metallk.* **45,** 4, 188–193, Apr. 1954.

Two types of equipment are available, one for production-line inspection and the other for laboratory work. The production-line instruments determine conductivity and permeability effects from which conclusions can be drawn on the alloy and on the heat treatment. Diameter and any flaws can also be determined. The laboratory-type instruments may be used to detect the physical properties as a function of temperature and for the investigation of corrosion.

The production-line instruments are applied mostly to sort smaller parts according to hardness, alloy, and flaws. For the tests, these parts may be placed individually in the instrument or, in the case of tubes or rods, these parts may continuously flow through it. Changes in these parts are read by observing the screen of a cathode-ray tube. A single spot on the face of the tube may move or the principal axis of an ellipse with the vertical axis may change its angle. R. O. Fehr, USA

1387. Förster, F., Theoretical and experimental principles underlying the eddy-current test method for nondestructive testing of material. VI. Noncontacting measurement of thickness of conductivity of metallic surface layers and steel sheets (in German), *Z. Metallk.* **45,** 4, 197–199, Apr. 1954.

The nondestructive testing of tubes and rods has been described by Förster in other papers (see preceding three reviews). Also described was the testing of steel sheets with coils which are in physical contact with the pieces under test. This paper now

deals with a testing method where a primary coil is located at a distance above the sheet and a secondary coil at a distance below the sheet. Another arrangement provides for the location of the primary as well as the secondary coil on the same side of the sheet. None of these coils are making physical contact with the surface.

As in the arrangements described before, a "limit frequency" is calculated. This is a function of electrical conductivity, thickness, relative permeability, and distance of the coils from the surfaces. The real and imaginary components of the secondary coil output voltage are plotted for various frequency ratios of test frequency to limit frequency. A law of similarity is then established, which says that "Any metal at any thickness furnishes the same constants if the same frequency ratio is maintained." Thickness, permeability, and conductivity of the sheet can then be determined from these readings.

R. O. Fehr, USA

Mechanical Properties of Specific Materials

(See also Revs. 1339, 1366, 1371, 1379, 1383, 1509, 1534)

1388. Withey, M. O., and Washa, G. W., Materials of construction, New York, John Wiley & Sons, Inc.; London, Chapman & Hall, Ltd., 1954, viii + 870 pp. $9.

1389. Hall, A. M., Nickel in iron and steel, New York, John Wiley & Sons, Inc.; London, Chapman & Hall, Ltd., 1954, xii + 595 pp. $10.

Book presents in about 500 pages a summary of the effects of nickel on steels and cast irons. Approximately 250 pages are devoted to wrought steels which account for at least 3/4 of the nickel used in low-alloy steels and irons; and 200 pages to cast steels and irons. The bibliography contains 784 references, of which only 24 relate to papers published from 1950 to 1953. The last Russian paper included was published in 1948 and the last German paper in 1944. The author explains this rather incomplete coverage of recent work by the fact that the original manuscript was completed in 1942 and had to be completely revised. This revision apparently was based primarily on trade literature, particularly on "Steel castings handbook" and on data supplied by the International Nickel Co. Furthermore, information on a number of topics, particularly relating to heat-treated steels where nickel plays an important role, is practically absent. This applies, for example, to embrittlement of bolting steels, the general subject of aircraft steels, to effects of silicon on these and other steels, to effects of aluminum, to fatigue properties, to properties of large sections, to transverse properties, and to flash welding. G. Sachs, USA

1390. Zwikker, C., Physical properties of solid materials, New York, Interscience Publishers, Inc., 1954, viii + 300 pp. $8.75.

1391. Newhouse, D. L., Seguin, B. R., and Lape, E. M. Some 12 per cent chromium alloys for 1000 F to 1200 F operation, *Trans. ASME* **76,** 7, 1107–1120, Oct. 1954.

See AMR 7, Rev. 2172.

1392. Rawson, H., The glass sealing properties of titanium and zirconium, *Brit. J. appl. Phys.* **5,** 10, 552–553, Oct. 1954.

Titanium and zirconium may be sealed to standard sealing glasses, without the need for any special sealing techniques, to give strong vacuum-tight seals with low stresses in the glass. If a flame-sealing method is used it is necessary to keep the sealing time as brief as possible, since the expansion characteristics of both metals change appreciably on prolonged heating in air.

From author's summary

1393. Karsai, I., and Balogh, I., Modified cast iron, a new material for the Hungarian mechanical-engineering industry (in Hungarian), *Maygar Technika,* **8,** 3, 186–189, 3 figs., 1 tab., 1953.

The physical properties of cast iron can be influenced by the formation of graphite. A description is given of the draft of Hungarian standards for modified cast iron. The physical properties of modified cast iron, such as fatigue limit, resistance to wear, machinability, resistance to corrosion and heat, are described. Modified cast-iron objects are seldom subjected to heat treatment since articulated castings may easily break thereby. Modified cast iron is not just ordinary cast iron of a higher strength; it has some very valuable properties such as insensitiveness to differences in wall thickness, resistance to wear, insensitiveness to chemicals, etc. The article concludes by listing some forms of its application in practice.

Courtesy of Hungarian Technical Abstracts I. B.

1394. Rastrup, E., Heat of hydration in concrete, *Mag. Concr. Res.* **6,** 17, 79–92, Sept. 1954.

Paper traces the development of a function between time and temperature, which makes it possible to refer the process of hardening of concrete at varying temperature to hardening at constant temperature.

It is further shown that it is possible to predetermine the temperature of concrete during hardening when properties of concrete, sizes and shape of the specimen, insulation, and external temperature are known. The time temperature function can also be applied to the development of strength. The validity of the theory is demonstrated by the results of tests upon 27 American and 3 Danish cements. From author's summary

1395. Furutani, K., Young's modulus and thermal expansion coefficient of Japanese lacquer, by means of bi-plate, *Proc. 1st Japan nat. Congr. appl. Mech.,* 1951; Nat. Committee for Theor. appl. Mech., May 1952, 15–18.

Expressions are given and equipment described for determining Young's modulus and coefficient of thermal expansion of a lacquer when applied to a copper strip of known elastic and expansion properties. Young's modulus was determined from measurements of midspan deflection of the composite specimen in a simple bend test, while the expansion coefficient was determined from the angle deflected by the free end of a cantilever of a composite specimen due to temperature (bimetal effect). The technique should be applicable to other coatings or claddings.

W. H. Duckworth, USA

Hydraulics; Cavitation; Transport

(See also Revs. 1297, 1357)

1396. Kalweit, H., Water balance [Der Wasserhaushalt], Vols. 1, 2, Berlin, VEB Verlag Technik, 1953, 408 pp., 200 figs.; 277 pp. of tables, figs., 8 maps.

The numerical evaluation of the water circuit in nature is one of the most complicated problems of hydrology. Its knowledge is extremely important for a rational control of water resources. Computation of water balance, precipitation, runoff, evaporation, and storage (originated by Keller) was limited to "water-year" periods. Fischer and Wundt extended analysis to half years and separate months. This work by Kalweit is a further

development of new German methods. Author reviewed previous data and applied modern methods. Work is done with care and precision and is of great value for hydrology.

It is regrettable that the work was confined to Eastern Germany in its contemporary limits. The second volume contains extensive tables, diagrams, and maps. S. Kolupaila, USA

1397. Friedrich, W., ed., Forest and water (Wald und Wasser), Mitteilungen des Arbeitkreises "Wald und Wasser," 1, Koblenz, 1954, 53 pp.

These reports were presented at a special meeting at Konstanz, June 1953, devoted to the hydrological significance of forests. Reports include: W. Friedrich, Introduction; H. Burger, Influence of forests on water balance; B. Huber, Water consumption of forest; W. Nägeli, Wind protection; J. Delfs, Rain interception in fir forests of different age; K. Korfsmeier, Influence of forest on ground water; H. Jordan, Decrease of crops and degradation of soils due to low ground water.

These interesting contributions by European authorities are of value for hydrologists interested in ground-water conservation. S. Kolupaila, USA

1398. Richter, H., Hydraulics of pipe flow. Handbook for design flow calculations [Rohrhydraulik. Ein Handbuch zur praktischen Strömungsberechnung], Berlin, Springer-Verlag, 1954, xi + 328 pp., 217 figs., 68 tables. DM 34.50.

An attempt is made to reduce to practical and directly applicable considerations the modern theories of fluid mechanics, as applied to the technically important subject of pipe-line flow.

Basic mechanical and thermodynamical concepts are first established: fluid properties, fundamental principles and equations, similitude.

Theoretical analysis and experimental results are combined in the discussion of the essential subjects: flow in straight cylindrical pipe (laminar and turbulent, smooth and rough), flow in straight pipes with noncylindrical or varied section, flow in bends, elbows, T's, etc.

The main difference between the second edition of the handbook and the first, published in 1934, lies in the general use of the resistance formula for turbulent pipe flow known as the Prandtl-Colebrook equation.

Numerical examples are given and the numerous experimental pipe-flow equations are critically discussed. Advice is given on their use and range of applicability. Tables and diagrams supply a wealth of useful information. A. L. Jorissen, USA

1399. Agroskin, I. I., Determination of conjugated depths in parabolic channels (in Russian), *Gidrotekh. i Melior.* **6,** 11, 62–64, Nov. 1954.

Universal function is derived $(1 + \eta^4)/\eta^{1.5}$ where η is h/A; $A = 0.518Q^{1/3}/p^{1/4}$, p a parameter of parabola. Table is given for direct reading of conjugated depths. Critical depth corresponds to a value of 0.88. Method seems to be convenient for natural channels. S. Kolupaila, USA

1400. Taliev, V. N., Angular lateral outflow of fluids from a conduit having a constant cross section (in Russian), *Dokladi Akad. Nauk SSSR (N.S.)* **94,** 4, 635–638, Feb. 1954.

Paper deals with lateral outflow from a canal and presents equations to determine coefficient of discharge. The solution is arrived at mathematically through use of conformal transformations for two-dimensional flow. A nomograph is given for use in determining the coefficient of contraction and the angle of outflow. A table gives comparative data, computed coefficients of contraction, and experimental observations. The relation is reasonably close. M. C. Boyer, USA

1401. Kobernik, S. G., Discharge coefficient for a low trapezoidal overflow weir (in Russian). *Gidrotekh. Stroit* **23,** 6, 36–38, 1954.

Discharge coefficients for low overflow weirs (with their height 0.5 to 2 times water head) depend on the slope of their face and on the ratio of head to the top width. Experiments showed that these coefficients are up to 13% lower than usually recommended for an inclined upstream face; congruence is better when upstream face is vertical and downstream face is inclined. S. Kolupaila, USA

1402. Tollenaar, D., The rise of liquids into a wedge-shaped crevice, *Appl. sci. Res. (A)* **4,** 5/6, 453–456, 1954.

1403. Owen, W. M., Laminar to turbulent flow in a wide open channel, *Trans. Amer. Soc. civ. Engrs.* **119,** 1157–1164, 1954.

For open channel flow, both the critical Reynolds number and the friction factors are less well established than for pipes but are known to vary with the channel shape. Author proceeds from equations of Navier-Stokes to derive expressions for velocity distribution for laminar flow for rectangular channels of finite and infinite widths. Experiments were made in a smooth rectangular channel 1.5 ft wide and with depths up to 3 in. and which was assumed to behave as a wide channel. Results showed good agreement with derived equation in laminar region and a nearly constant friction factor in turbulent range with transition at Reynolds number of 4000 to 11,000. Discussion of paper questions assumption of two-dimensional flow and shows that, had side effects been considered in turbulent region, agreement with Blasius equation would have been better. W. DeLapp, USA

1404. Oki, I., Kawaguchi, T., and Ishii, T., Relations between the Reynolds numbers and the flow distributions in some simple pipe nets, *Proc. 1st Japan nat. Congr. appl. Mech.*, 1951; Nat. Committee for Theor. appl. Mech., May 1952, 385–390.

Flow-rate ratios are calculated for several two-pipe branching and reuniting configurations. The computations are compared with experiments. L. Talbot, USA

1405. Asakawa, Y., and Ishida, G., Increase of velocity of solid and fluid flow, *Proc. 1st Japan nat. Congr. appl. Mech.*, 1951; Nat. Committee for Theor. appl. Mech., May 1952, 377–380.

Experiments reported show that when a high a-c or d-c voltage is applied to an orifice through which a solid-liquid suspension flows, the mass flow is increased. Also a heavy oil which discharges as discrete drops from the orifice can be made to flow continuously when an electric field is applied. The effect is ascribed to ionization and consequent mutual repulsion of the particles, which produces flow divergence downstream of the orifice. The discharge increase was about 20% for 10 kv a-c. L. Talbot, USA

1406. Polubarinova-Kochina, P. Ya., Theory of deposition on dams (in Russian), *Inzhener. Sbornik, Akad. Nauk SSSR* **16,** 193–202, 1953.

The present paper is on elaboration of a paper by Gavrashenko in *Gidrotekh. Stroit.* no. 5, 1950. In the present paper the grain-size distribution of the deposits is taken into account.

The variation of the shape of the free surface of the deposits is studied as a function of time and of the grain-size distribution. A. Gordon-Foster, England

1407. Buzzell, D. A., Recent trends in hydraulic gate design, *Proc. Amer. Soc. civ. Engrs.* **80,** Separ. no. 517, 14 pp., Oct. 1954

1408. **Dmitriev, G. T., Hydraulics of a steady nonuniform underground flow in prismatic aquifers** (in Russian), *Gidrotekh. i Melior.* **6**, 11, 44–50, Nov. 1954.

Differential equation of flow through porous medium is applied to a prismatic aquifer of any shape on the impermeable aquiclude and integrated for a horizontal or inclined bottom with positive or adverse slope. Results are similar to nonuniform flow in prismatic open channels. Available tables of integrals (e.g., by Bakhmeteff) can be used for numerical computations. Kinetic energy member can be neglected. Determination of the cross-section form of the assumed prismatic aquifer is questionable.

S. Kolupaila, USA

1409. **Birkhoff, G., Note on Taylor instability,** *Quart. appl. Math.* **12**, 3, 306–309, Oct. 1954.

Purpose of this note is to show that, in spite of the fact that the denser liquid is being accelerated toward the lighter vapor, *collapsing bubbles are unstable*, and that this result is unaffected by surface tension (though it may be affected by viscosity or thermodynamic considerations). The proof of this fact depends on a consideration of the stability of differential equations near regular singular points: the instability is algebraic and not of the exponential type usually considered.

From author's summary

Incompressible Flow: Laminar; Viscous

(See also Revs. 1277, 1404, 1405, 1408, 1435, 1467, 1470, 1485, 1497, 1498)

1410. **Morgan, G. W., On the non-steady motions of a rigid body in an ideal fluid,** *Quart. appl. Math.* **12**, 3, 277–285, Oct. 1954.

It is known [H. Lamb, "Hydrodynamics," 1932, chap. 6] that for any rigid body moving in an ideal fluid there exist three directions (of permanent translation) such that if it is set in motion along one of them and left to itself, it will continue to do so. The author investigates whether the same is true if the body is acted on by a force. He finds that if the shape of the body satisfies three conditions, there exist three axes, each parallel to one of the directions of permanent translation such that if the line of action of the force coincides with one of them, then once the body is set moving along it, it will continue in the same direction. In general, the axes do not intersect.

For plane motion the two axes always exist, and, further, if the body is set rotating about their point of intersection under a couple, it will continue to rotate without translation. There is thus an analogy between this point and the center of mass of a rigid body *in vacuo* but, since the fluid problem is nonlinear, the analogy is restricted to the specific motions mentioned.

Similar results are proved for a body of revolution.

K. Stewartson, England

1411. **Levin, E., Note on the circle theorem of hydrodynamics,** *Quart. appl. Math.* **12**, 3, 315–316, Oct. 1954.

The circle theorem is concerned with the irrotational two-dimensional flow of an incompressible inviscid fluid in the z-plane. Let $f(z)$ be the complex potential of flow. Then, if there are no singularities within a radius a of the origin and *no rigid boundaries* in the plane, the appropriate flow function after introducing a circle $|z| = a$ about the origin is given by $g(z) = f(z) + f^*(a^2/z)$, where * denotes conjugation.

The purpose of this note is to show that the restriction on rigid boundaries may be somewhat relaxed.

From author's summary

1412. **Riddell, F. R., The jettisoning of liquids from an airplane in flight,** *Douglas Aircr. Co. Rep.* SM-18279, v + 62 pp., 23 figs., 4 refs., Mar. 1954.

The problem of how to jettison fluids from an airplane in flight so as to avoid contamination of the aft section is discussed. Main physical factors and influencing features are investigated to find a rational approach to nozzle design. Results of some simple experiments and discussion of difficulties of model testing are given.

The process of formation and spreading of the spray of liquid drops may be described as follows: (1) The instability of small disturbances at the liquid-air interface causes a rapid disintegration of the liquid jet. (2) A mixing region comes into being in which the liquid drops and the local airstream interchange momentum until a mean velocity is reached. (3) Downstream of the mixing region the spray has the character of an ordinary wake, except for the inclusion of liquid drops. In the mixing region the spray shape can be changed considerably by changes of nozzle geometry. The wake region, however, can be controlled most effectively by changes in the flow rate of the liquid. Tentative parameter ranges are established to determine the relative importance of these regions under different conditions, whereby a basis for nozzle design and model testing is provided.

A detailed mathematical theory is given: (1) Of the dynamic instability of a liquid jet; (2) of the motion of a drop of liquid ejected laterally into an airstream; and (3) of the spreading of the wake.

From author's summary by K. J. De Juhasz, Germany

1413. **Taylor, Sir Geoffrey I., The use of a vertical air jet as a windscreen,** "Mémoires sur la mécanique des fluides," *Publ. sci. tech. Min. Air, Paris*, 313–317, 1954.

Paper presents an approximate theory of the deflection of a two-dimensional vertical jet by a horizontal wind. Equations used for finding the shape of the center line of the jet are derived by using the following assumptions: (1) The jet is so narrow that it may be represented by its center line; and (2) the pressure in the shielded area is equal to the pressure in the undisturbed wind. A few errors in the constant of the equations were found: (1) The expression $(w_0^2 b/U^2 C)$ in Eq. 8 should be $2(w_0^2 b/U^2 C)$; (2) the expression $(w_0^2 b/U^2)$ of the equation following Eq. 8 should be $2(w_0^2 b/U^2)$; and (3) the constant of the expression for C_0/C for the case $n = 0$ should be 3 instead of 2.

S.-M. Yen, USA

1414. **Rumer, Yu. B., Convective diffusion in a submerged jet** (in Russian), *Prikl. Mat. Mekh.* **17**, 6, 743–744, Nov./Dec. 1953.

Paper extends the problem of laminar submerged jet emerging from a small-diameter tube into the infinite space occupied by the same incompressible fluid [title source, **16**, 2, 1952] to the case of solutions. In addition to the continuity, and Navier-Stokes equations used previously (ibid.), equation of convective diffusion, $\operatorname{div}(c\bar{v} - D \operatorname{grad} c) = 0$, is employed. Author finds the flow of solute purely radial and gives specific solution of problem for a weak jet. According to author, the investigated problem offers the first example in which convective diffusion equation offers an exact solution.

H. Hurwicz, USA

1415. **Dean, W. R., Note on the motion of viscous liquid past a parabolic cylinder,** *Proc. Camb. phil. Soc.* **50**, part 1, 125–130, Jan. 1954.

An approximate solution of the title problem is calculated in parabolic coordinates for a steady two-dimensional flow. A particular case is the flow past a flat plate, which is very similar

to that given by boundary-layer theory. The stream function agrees with Carrier and Lin [AMR 1, Rev. 857].

Results indicate a viscous layer surrounding the cylinder; there is an inner region of this layer where the stream function is biharmonic and there is a slow fluid motion. The error in the solution is found to be small. H. G. Lew, USA

1416. Reissner, H. J., The irrotational flow pattern in an incompressible non-viscous fluid, produced by a circular double source (suction), disk-surface, and by an inflow toward the suction surface perpendicular to the surface, "Mémoires sur la mécanique des fluides," *Publ. sci. tech. Min. Air, Paris,* 263–269, 1954.

Reviewer believes solution given is wrong because of incomplete consideration of boundary conditions in the plane of the disk. The correct answer is essentially given by Lamb ["Hydrodynamics," ¶ 108). If, in his Eq. 3, one sets $e = 1$, $A = 2c(w_0 - w_\infty)/\pi$ and subtracts $\frac{1}{2}w_\infty r^2$ from ψ, the correct result for uniform suction follows. The correct solution differs from the present author's in being singular at the edge of the disk.

S. H. Maslen, USA

1417. Harvald, S. A., Three-dimensional potential flow and potential wake, *Trans. Dan. Acad. tech. Sci.* no. 2, 39 pp., 1954.

The Rankine bodies generated by various combinations of sources and sinks, situated at isolated points or distributed over lines and surfaces, are computed. The purpose of the work is to compute by this means the velocity field due to the ship's hull in the neighborhood of the propeller. Since the effect of the ship's boundary layer on the potential flow is neglected, the results should be only roughly applicable for this purpose.

L. Landweber, USA

1418. Wu, Y. T., A theory for hydrofoils of finite span, *J. Math. Phys.* **33,** 3, 207–248, Oct. 1954.

The characteristics of a hydrofoil of finite span moving with constant velocity through deep water at a fixed distance beneath the free surface are investigated. The liquid medium is considered incompressible, nonviscous, and of infinite depth. Local induced velocities at the hydrofoil are calculated from the left distribution along the lifting line, free water-surface pressure condition, and wave formation. Thus the problem depends upon two-dimensional characteristics of the hydrofoil section together with proper modification of free-stream velocity and effective angle of attack. An example is worked out and detailed calculations of lift and drag coefficients are shown. The effects of free water surface and wave formation are examined in detail.

G. V. R. Rao, USA

1419. Hawthorne, W. R., The secondary flow about struts and airfoils, *J. aero. Sci.* **21,** 9, 588–608, 648, Sept. 1954.

Theoretical and experimental investigations are given for the flow about an airfoil when the approaching velocity varies in the spanwise direction. The theoretical development assumes an inviscid, incompressible flow. It is also supposed that the flow may be regarded as a small disturbance of the two-dimensional potential flow around the given profile at each spanwise station. Because of these restrictions the author shows the theory to be inapplicable to round-nosed struts. The theory does apply for profiles with sharp noses. For a bicusped profile, which is shown to be a shape of least disturbance to the flow, the downstream vorticity and the energy in the secondary flow normal to the direction of the approaching flow are calculated for one such profile with one type of initial velocity distribution. Similar calculations are presented for a biconvex profile and the results compared with the bicusped profile strut. Calculations are also given for a lifting airfoil of thin circular arc section. It was found from this example that a trailing vortex sheet exists which extends outside the approaching boundary layer.

Experimental results were obtained in a water tunnel and in a wind tunnel. A water channel with a sandy bottom was used to investigate scouring of the bottom caused by the secondary flow. These experiments, performed on several shapes, indicated that the use of the bicusped profile lessens the disturbances caused in the flow of a nonuniform stream about a strut. In the wind tunnel, experiments of the drag of a bicusped profile in nonuniform flow were compared with that of a conventional strut. Also the energy in the secondary flow was measured and compared with the theory. Fair agreement was obtained. The experimental results confirmed the major results predicted by the theory. In particular, the influence of the nose shape upon the magnitude of the secondary disturbances is accounted for qualitatively. B. R. Parkin, USA

Compressible Flow, Gas Dynamics

(See also Revs. 1277, 1440, 1448, 1450, 1455, 1489)

1420. Spalding, D. B., Compressible flow of a semi-perfect gas, *Engineering* **177,** 4612, 777–781, June 1954.

Author presents a very interesting and useful graphical representation of the important engineering quantities used in the flow of a compressible gas. The gas is semiperfect, i.e., has specific heats which are a function of temperature. The coordinates of the graph are log T and log V, where T is temperature and V velocity. Lines of constant energy, constant entropy, constant $w/A_p = V/RT$, constant momentum, and the sonic line are plotted. Various graphical distances are shown to have physical significance, such as Mach number, pressure change resulting from heat addition, shock waves, etc. Engineering use of graph is demonstrated for nozzle design, heat addition to gas flow in pipes, shock waves, compressible flow with chemical reaction, deflagration, detonation, gas turbines, and ejector design.

Reviewer believes this is a very informative and useful tool for engineering applications in compressible flow.

R. A. Gross, USA

1421. Van Dyke, M. D., The second-order compressibility rule for airfoils, *J. aero. Sci.* **21,** 9, 647–648, Sept. 1954.

Paper outlines simple method for obtaining second-order subsonic pressure distribution on any thin two-dimensional airfoil in terms of pressure distribution for incompressible flow. First-order compressibility correction is found by Prandtl-Glauert rule, and second-order correction is then derived from Hayes result [British ARC 15,722] for ratio of second to first-order terms. Compressible flow past ellipse at zero angle of incidence, and lifting symmetrical Joukowsky airfoil are considered as examples. D. W. Holder, England

1422. Holder, D. W., Chinneck, A., and Gadd, G. E., An experimental investigation of the interaction of a shock wave with a subsonic stream bounded by a wall, *Phil. Mag.* (7) **45,** 369, 997–1009, Oct. 1954.

An experimental study has been made of a model of a boundary layer consisting of a subsonic stream bounded on one side by a wall and on the other by a supersonic main stream. The subsonic stream was approximately uniform at the point where it first met the main stream, but it became progressively less uniform downstream of this point because of mixing with the main stream and the growth of the boundary layer at the wall.

Particular attention is given to the pressure rise which takes place at the wall when a wedge is attached to it. It is found that the pressure begins to rise ahead of the apex of the wedge, and that the magnitude of this upstream effect increases as the Mach number of the secondary stream is reduced. A comparison between the measured values of the upstream effect and the values predicted by a theory which has been advanced by Lighthill shows reasonable agreement.

From authors' summary by T. Gullstrand, Sweden

1423. Naylor, V. D., The shock-wave cubic, *Aircr. Engng.* **26,** 310, 407–409, Dec. 1954.

Elementary discussion of theoretical shock-wave relations and properties. J. H. Giese, USA

1424. Mucklow, G. F., and Wilson, A. J., Wave-action in gases: The attenuation and reflection of compression waves propagated in pipes. Parts I, II, *Inst. mech. Engrs. Proc.*, 12 pp., 1954.

Paper studies theoretically and experimentally the influence of friction on the unsteady flow through pipes. It continues AMR **2**, Rev. 1524. A cylinder discharges suddenly compressed air into a pipe of the same diameter and thus establishes a wave system which propagates. The pressures are measured at different stations of the pipe. Experiments use pipes and cylinders of different diameters. The quantity studied is mainly the pressure decay at the wave head. Theoretical investigations valid for small pressure perturbations give a simple relation between the pressure gradient in the wave and the pressure gradient in a steady flow. Guided by this result a formula is derived which represents the decay of the wave head over a range of pressure ratios and lengths of the pipe. Furthermore, the reflection of a wave at the closed or open end of a pipe is studied experimentally and compared with theoretical predictions. G. Guderley, USA

1425. Bers, L., Existence and uniqueness of a subsonic flow past a given profile, *Comm. pure appl. Math.* **7,** 3, 441–504, Aug. 1954.

General existence and uniqueness theorems for two-dimensional uniformly subsonic flows of inviscid gases past given profiles are proved under the conditions that the stream is uniform at infinity and either the Kutta-Joukowsky condition is satisfied at sharp trailing edges or the circulation is given when the profile is smooth. Certain other theorems for modifications of these conditions are proved or stated. The results are of considerable generality, and, in consequence, the analysis is too involved for adequate summary in these Reviews.

Mathematicians interested in the theory of nonlinear differential equations will read this paper with profit; for engineering purposes it is sufficient to know that the results can be and have been proved. G. N. Ward, England

1426. Manwell, A. R., A new singularity of transonic plane flows, *Quart. appl. Math.* **12,** 4, 343–349, Jan. 1955.

Author shows that the limit line singularity in the hodograph plane (defined by locus $J = \partial(x,y)/\partial(\theta,q) = 0$) does not occur in transonic flow if physical boundary has finite curvature and the hodograph map of this boundary has a continuously turning tangent not in the characteristic direction.

Author then shows that, if a single corner discontinuity in slope is admitted on hodograph image of physical boundary in supersonic region, the fluid acceleration becomes infinite on sonic line in the neighborhood of this corner, i.e., flow breaks down.

Author obtains expression for expansion about this point and shows the solution can be continued across the sonic line. He discusses approximate computations of flows about arbitrary convex bodies placed in flow of gradually increasing Mach number. These indicate that as Mach number is increased the velocity distributions along the boundary do give a hodograph plane corner at the point of maximum supersonic velocity. They also indicate cases in which the singularity and resulting breakdown of flow occur only after the supersonic region has reached considerable size. S. F. Borg, USA

1427. Miles, J. W., On the transonic drag of accelerated bodies, *J. aero. Sci.* **21,** 9, 644–645, Sept. 1954.

The purpose of the present note is to show that previous results of slender body theory lead to a rather more general form of the result, paralleling the supersonic drag integrals of Ward and von Kármán. From author's summary

1428. Laitone, E. V., and Nielsen, H., Transonic flow past wedge profiles by hydraulic analogy, *J. aero. Sci.* **21,** 7, 498–499, July 1954.

1429. Talbot, L., and Laitone, E. V., Remarks on compressible flow actuator disc theory, *J. aero. Sci.* **21,** 9, 638–639, Sept. 1954.

1430. Haack, W., and Zierep, J., Method for computing Laval nozzles based on equations used for the flow in nozzle throats (in German), *Z. Flugwiss.* **2,** 2, 41–50, Feb. 1954.

Flow in the throat of a Laval nozzle whose geometry is prescribed, $r = f(x)$ being the meridian, is calculated, assuming that streamlines are near to $r = \lambda f(x)$ curves. Basic equations are expressed in function of x, λ and simplified, obtaining a series solution that improves Sauer's. Standard method of characteristics is applied to continue solution in supersonic region. Some examples are given. G. Moretti, Argentina

1431. Germain, P., General theory of conical flows and its application to supersonic aerodynamics, *NACA TM* 1354, 333 pp., Jan. 1955. (Translation of *ONERA Publ.* 34, 1949.)

See AMR **3,** Rev. 2402.

1432. Lock, C. N. H., and Tomlinson, R. C., The use of tensor notation to develop characteristic equations of supersonic flow, *Aero. Res. Counc. Lond. Rep. Mem.* 2632, 18 pp., Mar. 1949, published 1954.

The characteristic surface and equation for the general steady three-dimensional nonviscous compressible flow are derived by using the general curvilinear coordinates. With the help of tensor notation and calculus, the whole analysis is extremely simple. The corresponding results for the two special cases when the flow field is two-dimensional and axial-symmetric are worked out in detail. Further applications of the tensor calculus are given in the derivation of the dynamic relations along and across a streamline, and in the discussion of simple waves. While no new results are obtained, the method may find applications in other branches of mechanics. B.-T. Chu, USA

Wave Motion in Fluids

(See also Rev. 1277)

1433. Ippen, A. T., and Harleman, D. R. F., Verification of theory for oblique standing waves, *Proc. Amer. Soc. civ. Engrs.* **80,** Separ. no. 526, 1–17, Oct. 1954.

Changes in section or alignment of open channels flowing at supercritical velocities give rise to depth changes which may be

abrupt or gradual, depending on the type of wave produced. A series of experiments were undertaken to verify the hydrodynamic theory for both oblique hydraulic jumps and expansion waves with Froude numbers ranging from two to seven. The position of the standing waves caused by a wall deflection and the associated depth changes were observed and compared with existing theory. The average agreement was of the order of 2% for oblique jumps, with a somewhat larger discrepancy for the expansions depending on the magnitude of the wall deflection.

An analysis and experimental observations of the nature of the transition between undular and roller-type jumps are presented. It is shown that the transition occurs at a ratio of two.

From authors' summary

1434. Friedrichs, K. O., and Hyers, D. H., The existence of solitary waves, *Comm. pure appl. Math.* **7,** 3, 517–550, Aug. 1954.

Authors establish the possibility of a permanent (i.e., steady when observed with appropriate velocity) two-dimensional irrotational flow of liquid, acted upon by gravity, which is at rest at infinity and which has a free surface with a finite altitude over a horizontal bottom.

The problem is quickly introduced and described mathematically in the first two sections of the paper. An expansion procedure is explained in section 3, which not only gives the usual first approximation, obtained long ago in various ways by several authors, but leads in principle to higher-order approximations and forms the basis of the existence proof. The next two sections are devoted to Green's function for a related linear problem, and to the setting up of necessary integral equations by means of this function. Certain function spaces are introduced in section 6 in order to solve the integral equations. Finally, in section 7, authors establish their existence theorem which states that when gh/U^2 is less than one, but differs from one by a sufficiently small amount, a symmetric solitary wave of velocity U exists, h being the depth of liquid at infinity, and g the acceleration due to gravity. G. Power, England

1435. Khaskind, M. D., About wave motions of heavy fluids (in Russian), *Prikl. Mat. Mekh.* **18,** 1, 15–26, Jan./Feb. 1954.

Author considers an incompressible fluid unbounded below its surface (sonar). Practically useful results are obtained for three cases: (1) A point source at rest below the surface; (2) a horizontal line source of infinite length at rest; (3) like (2), but moving with constant horizontal velocity. In all cases the equations are linearized, i.e., the amplitudes small.

The point-source velocity potential as carried out by author contains a term with a Hankel function. This, however, would correspond to an additional vertical line source of no reality. But the remaining terms alone satisfy the Laplace equation and the boundary conditions and give the complete solution. Except for this, only elementary functions are involved.

Assumed incompressibility restricts range of validity rather seriously: Product of the distance from source and the angular frequency must be small against velocity of sound in water, i.e., 0.9 mile per sec. At larger distances the phase angle cannot be considered to be zero and Laplace's equation is no longer a legitimate substitute of wave equation. G. Plato, Germany

1436. Zienkiewicz, O. C., and Hawkins, P., Transmission of water-hammer pressures through surge tanks, *Proc. Instn. mech. Engrs.* **168,** 23, 629–642, 1954.

Paper presents results of experimental investigation into way in which water-hammer pressures are transmitted through various types of surge tank. Orifice and differential surge tanks are subject to special scrutiny, as in those instances the validity of the assumptions of the plane-fronted wave theory has frequently been subjected to doubt. Experimental results confirm simplest and obvious assumptions. Adaptation of Schnyder-Bergeron method is presented which allows transmitted pressures to be accurately estimated for most surge tanks. Some general formulas together with solutions of particular examples are included.

From authors' summary by J. S. McNown, USA

1437. Hayashi, T., Mathematical theory of flood waves, *Proc. 1st Japan nat. Congr. appl. Mech.*, 1951; Nat. Committee for Theor. appl. Mech., May 1952, 431–436.

The height of the flood wave traveling downstream in an open channel with uniform cross section is studied. A formula for the diminution factor for the peak wave is deduced and shows a very close agreement with the data observed at a field experiment made in the river Edo, Japan. K.-J. Sundquist, Sweden

Turbulence, Boundary Layer, etc.

(See also Revs. 1403, 1422, 1498, 1499, 1515, 1535)

1438. Morkovin, M. V., and Bradfield, W. S., Probe interference in measurements in supersonic laminar boundary layers, *J. aero. Sci.* **21,** 11, 785–787, Nov. 1954.

The purpose of this note is to present direct visual evidence of strong interference near the wall and to discuss its implications.

From authors' summary

1439. Eujen, E., Experiments for artificially producing thick laminar boundary layers (in German), *Z. Flugwiss.* **1,** 7, 170–175, Dec. 1953.

Thick boundary layers were produced on a flat plate by injecting air through a porous wall in the hope that the layer would still be laminar. The mean velocity profiles could be made to resemble laminar velocity distributions, but hot-wire turbulence level readings indicated one or two highly turbulent zones, depending on injection rates. Truly laminar layers were obtained only with no injection. L. S. G. Kovasznay, USA

1440. Evvard, J. C., Tucker, M., and Burgess, W. C., Jr., Transition-point fluctuations in supersonic flow, *J. aero. Sci.* 21, 11, 731–738, 748, Nov. 1954.

Paper is quite similar to authors' *NACA TN* 3100 [see AMR 7, Rev. 2536], indicating that a sharp transition seems to occur from laminar to turbulent flow and that this flow pattern moves randomly along the aerodynamic surfaces. Additional data are now included, especially for Mach numbers in addition to 3.12. Surface is essentially adiabatic. Data indicate an apparent decrease in the Reynolds number of transition as flow Mach number changes from 1.9 to 3.12. M. Morduchow, USA

1441. Townsend, A. A., Turbulent friction on a flat plate, *European Shipbldg.* **4,** 3, 86–92, 1954.

In the classification of turbulent shear flows the boundary layer occupies a position intermediate between channel flow and free turbulence. Author discusses the characteristics of the turbulent boundary layer by first reviewing the modern picture of the structure of free turbulent and channel flows and then interpreting the flow in a boundary layer in terms of these two types of shear flows. In the thin layer close to the wall where most of the turbulent energy production and dissipation take place, a condition of universal similarity exists, determined by the wall stress and the viscosity as in the constant stress layer in a channel. The outer part of the boundary layer is intermittently turbulent with a slow decay rate and near homogeneity similar to the

characteristics of wake flow. The inner layer has little effect on the rest of the flow and merely adjusts its structure to absorb an energy flow determined by the entrainment processes of the outer layer. The consequences of the assumption of complete self-preservation for the outer and inner layers are investigated and good agreement with experimental shear stress distributions is obtained by suitable adjustment of the velocity scale for the outer flow. In a final section the effect of finite width on the turbulent drag or a flat plate is considered. L. M. Grossman, USA

1442. **Proudman, I., and Reid, W. H., On the decay of a normally distributed and homogeneous turbulent velocity field,** *Phil. Trans. roy. Soc. Lond.* (*A*) **247,** 926, 163–189, Nov. 1954.

Authors introduce three-point correlation of velocity components, and with it and the well-known two-point correlation examine the turbulence field. First, the kinematical properties of the three-point correlation are obtained with particular attention paid to the Fourier transforms giving the spectral tensors. In the particular case of isotropic turbulence, extensions to the invariant theory lead to the result that the three-point correlation is completely defined by two scalar functions. From Navier-Stokes equation two independent dynamical relations are derived which are determinate.

Results are applied to a few cases of decay of isotropic turbulence for which physical measurements are available. For large Reynolds numbers the exact solution of the inviscid equations for vorticity is obtained and shown to be consistent with Kolmogoroff's theory. The distribution of energy transfer is examined and is found to be satisfactory in the energy-containing range of the spectrum. Energy transfer in the large eddies is also examined and it is shown that the large eddies are not permanent during decay. A discussion of consequences follows in which it is shown that Loitsianskiĭ's integral is not an invariant of the motion. From authors' summary by W. D. Baines, Canada

1443. **Pearson, C. E., Corrections in hot-wire correlation measurements,** *Quart. appl. Math.* **12,** 3, 235–240, Oct. 1954.

It is shown that true turbulent velocity correlation can be obtained from the measured correlation when the latter is effected by imperfect velocity correlation and transient heat conduction along the length of the hot wire. The author has overlooked that this has been shown for the general case of a statistically homogeneous field. If a measured random field is related to the true field by a linear operator, then it is *always* possible to recover the true spectrum or correlation from the measured correlation or spectrum [AMR **6,** Rev. 2862]. M. S. Uberoi, USA

1444. **Davies, R. W., Energy spectrum of turbulence for the entire range,** *Phys. Rev.* (2) **95,** 4, 912–913, Aug. 1954.

Author considers an incompressible fluid in a statistical steady state of homogeneous isotropic turbulence; he suggests that $\langle\epsilon\rangle$ (mean dissipation per unit volume and unit time) plays a role in turbulence similar to temperature in the black-body radiation problem. It is known that there are two energy-transport processes in turbulence: inertial transfer and viscous dissipation. The point of view of the author is that, for the energy spectrum, the two limiting laws of Kolmogoroff-Onsager-Weiszäcker and Batchelor-Kármán-Lin are the result if only one process is present. Making the assumption that for a change in $\langle\epsilon\rangle$ each transport process changes independently of the other, he gives an expression for the energy spectrum.

J. Kampé de Fériet, France

1445. **Ogura, Y., and Miyakoda, K., Note on the pressure fluctuations in isotropic turbulence,** *J. meteor. Soc. of Japan* (II) **32,** 5/6, 160–166, May/June 1954.

The spectrum of the pressure fluctuations in isotropic turbulence is theoretically studied on the basis of an assumption that the joint probability distribution of turbulent velocities is normal, making use of an approximate representation for the interrelation between the longitudinal velocity correlation and the velocity spectrum. The three-dimensional pressure spectrum $\Pi_*(k)$ thus derived is: $\Pi_*(k) \sim k^{-7/3}$ for the intermediate wave-number range and $\Pi_*(k) \sim k^2$ for the low wave-number range, corresponding to the velocity spectra $F_*(k) \sim k^{-5/3}$ and $F^*(k) \sim k$, respectively. These theoretical results are compared with the pressure spectra observed in the westerlies zone of middle latitudes with fairly good agreement.

From authors' summary by C. C. Lin, USA

1446. **Hama, R., Experimental studies on isotropic turbulence** (in Japanese), *Rep. Inst. Sci. Technol. Toyko Univ.* **7,** 4, 145–174, Aug. 1953.

Paper contains the results of experiments carried out by the author a few years ago on the isotropic turbulence produced by a grid in an open-jet wind tunnel. Experimental results are presented of the decay of turbulent energy, the transverse velocity correlation, the probability distribution, and the spectrum of turbulence. I. Tani, Japan

1447. **Taliev, V. N., Basic laws of flow from a turbulent ring-shaped source** (in Russian), *Doklady Akad. Nauk SSSR* (*N.S.*) **94,** 3, 405–408, Jan. 1954.

A study was made of air flows from a radial opening of width $2b$, in the form of a ring with radius r, forming a jet. A mathematical analysis, applying principles of momentum and energy, is given. The meaning of the resulting equations and the uses to which they might be put are not clear.

M. C. Boyer, USA

Aerodynamics of Flight; Wind Forces

(See also Revs. 1276, 1412, 1490, 1496, 1506, 1508, 1509)

1448. **Tucker, W. A., Design considerations for wings having minimum drag due to lift,** *NACA TN* 3317, 26 pp., Dec. 1954.

The problem of increasing the range of supersonic aircraft by the use of twisted and cambered wings is considered, primarily for the purpose of developing a rational method for the selection of a design lift coefficient. Relations and curves are presented from which a suitable selection may be made, depending on the relative importance of maximum range and top speed.

From author's summary by T. H. Lin, USA

1449. **Stokes, F. H., and Mathews, C. W., Theoretical investigation of longitudinal response characteristics of a swept-wing fighter airplane having a normal-acceleration control system and a comparison with other types of systems,** *NACA TN* 3191, 50 pp., July 1954.

A study is made of a longitudinal control system with pitch rate and normal acceleration feedback, and a lag network in the forward loop. These form the inner loop of a flight-path-angle autopilot whose performance is computed for several conditions of Mach number and altitude, and compared to other systems.

Reviewer believes authors erred in their technique of optimization for comparison purposes. The system gains were adjusted to give peak amplitude ratios of 1.2 rather than peak amplitude ratio-static sensitivity ratios of 1.2. Also, full use was not made of the pitch-rate stabilization, since optimization of the pitch rate and normal acceleration gains were accomplished independently. If these gains were adjusted simultaneously to optimize the air-

plane short-period response to approximate a desired response, it is possible that the forward loop lag would not have been required. R. P. Harper, Jr., USA

1450. Gates, S. B., Swept wings in supersonic flight, *Aero. Res. Counc. Lond. Rep. Mem.* 2818, 10 pp., Dec. 1946, published 1954.

Opinion seems still unsettled on the aerodynamic merit of swept wings in supersonic flight. To elucidate this, Ackeret's theory of two-dimensional wave reaction is here extended to include sweep. The formulas so derived are used to compare the performance of a straight wing with one swept through 45 deg, making some allowance for frictional drag.

As the wave form-drag varies as $(thickness)^2$, it is this part of the drag which causes most trouble. A straight wing of given thickness/chord ratio can be swept through an angle ψ either by yawing it or by shearing it. In both cases the critical M is increased from 1 to sec ψ and the favorable lift/incidence effects above the critical M are the same. But the form-drag of the yawed wing begins to be less than that of the straight wing soon after $M = \sec \psi$ and is reduced in the ratio $\cos^2 \psi : 1$ at large M; while the form-drag of the sheared wing always exceeds that of the straight wing. Thus, to make the best use of sweep in a supersonic speed range beginning at $M = \sec \psi$, the straight wing thickness which must be tolerated should be yawed through an angle ψ. From author's summary

1451. Bartlett, G. E., and Vidal, R. J., Experimental investigation of influence of edge shape on the aerodynamic characteristics of low-aspect-ratio wings at low speeds, *Cornell aero. Lab. Rep.* CAL-62, 33 pp., 26 figs., June 1954.

Lift, moment, drag due to lift, and transverse load distribution at two stations of triangular wings (aspect ratios of 1.5 and 2.0) are presented for angles of attack up to about 40°. Each wing was tested with three different leading-edge shapes—beveled, elliptical, and circular. In addition, the lift and moment are presented for several approximately rectangular wings, some with retreating side edges. The force and moment characteristics (measured at a Reynolds number of several million based on root chord) are compared with linear theory and various viscous cross-flow estimates. The magnitude of the cross-flow contribution is shown to depend on the edge shape.

G. E. Nitzberg, USA

1452. Scharn, H., Systematic and critical sample calculations of the lateral stability of airplanes (in German), *Z. Flugwiss.* 2, 3/4, 57–95, Mar./Apr. 1954.

Abridged version of a paper published at LFA Braunschweig in 1943. Classical, rigid body, rudder-fixed, lateral stability calculations for 12 German propeller-driven airplanes with straight wings, $5.3 < AR < 9.3$, ranging from the single seat Ha 137 to the four-engine transport FW 200, and Ha 139 (pontoon plane). The following parameters are considered: aerodynamic shape, wing loading, mass and mass distribution, inclination of the flight path, load factor, and altitude. Approximate factorizations of the stability quartic are compared with exact roots to show value of approximate explicit expressions for Dutch Roll period and time constant, roll time constant, and spiral mode time constant. Effect on lateral stability derivatives of area, center-of-pressure-location, lift-coefficient curve slope, and sweepback angle of vertical fin are discussed. A. E. Bryson, Jr., USA

1453. Puttock, D. R., The effect of rolling on fin-and-rudder loads in yawing manoeuvres, *Aero. Res. Counc. Lond. curr. Pap.* 153, 26 pp., 5 figs., Jan. 1953, published 1954.

Approximate method is given for taking account of rolling motion of airplane when simplified analysis of maneuvering fin and rudder loads considering only yawing and sideslip has been made. Method consists of using the correct damping and frequency parameters for the three-degree-of-freedom problem (yawing, sideslip, rolling) in the response solution for yawing and sideslip alone. Necessity for considering product of inertia terms in three-degree-of-freedom lateral analysis of modern aircraft configurations is indicated, as also shown in much previous work on this subject. Comparison of exact and approximate response for several aircraft types is presented; for these cases, approximate result is excellent approximation to correct theoretical result. A. H. Flax, USA

1454. Jones, R., and Bell, A. H., Further experiments on an NACA 23021 aerofoil with a 15 per cent Handley Page slotted flap in the compressed air tunnel, *Aero. Res. Counc. Lond. Rep. Mem.* 2519, 16 pp., Aug. 1946, published 1954.

1455. Acum, W. E. A., Note on the effect of thickness and aspect ratio on the damping of pitching oscillations of rectangular wings moving at supersonic speeds, *Aero. Res. Counc. Lond. curr. Pap.* 151, 16 pp., May 1953, published 1954.

An estimate is made of the effect of variation of aspect ratio and thickness parameter on the damping derivative of a rectangular wing performing pitching oscillations in a supersonic stream. After a discussion of various theories of unsteady two-dimensional supersonic flow round airfoils, that due to Van Dyke is combined with the linearized supersonic theory for a rectangular flat plate to obtain the effect on the damping in pitch. The values given apply to wings of symmetrical biconvex section oscillating at low frequency, in a stream of Mach number such that the shock at the leading edge is attached.

From author's summary

1456. Molyneux, W. G., and Broadbent, E. G., Determination of reversal speed of a wing with a partial-span flap and inset aileron, *Aero. Res. Counc. Lond. Rep. Mem.* 2793, 10 pp., Feb. 1950, published 1954.

Control reversal due to deformation of a wing with a partial-span flap and inset aileron is considered theoretically for the particular case of a flap held at the root end. The semi-rigid method is used.

An investigation is made for a particular aircraft. The calculated reversal speed is found to be considerably lower than for the straightforward wing-aileron case. The effect of variation of the degrees of wing and flap constraint is also considered. It is concluded that an increase in reversal speed is best obtained by an increase in flap root stiffness. From authors' summary

1457. Seddon, J., and Trebble, W. J. G., Experiments on the flow into a swept leading-edge intake at zero forward speed with notes on the wider uses of a slotted intake, *Aero. Res. Counc. Lond. Rep. Mem.* 2909, 18 pp., Jan. 1951, published 1954.

The flow into a swept intake at zero forward speed (ground running conditions) is shown to be analogous to the flow round a sharp corner in a duct. Tests have been made on a model of a swept wing leading-edge intake to measure the losses involved.

It is found that the distribution inside the duct can be improved by the use of straight guide vanes, alternatively by means of a special intake slot, or further by a combination of both. Guide vanes increase the mean loss, but the intake slot improves (i.e., reduces) this also.

The slot would need to be sealed under flight conditions. It is suggested that this form of slotted intake may have wider applications in the future. Using the results of the experiments

and an analogy with the slotted wing, conclusions are drawn regarding the main points of design of the intake slot.

From authors' summary

1458. Walker, W. G., Gust-load and airspeed data from one type of four-engine airplane on five routes from 1947 to 1954, *NACA TN* 3358, 28 pp., Jan. 1955.

Paper presents the results of an analysis of approximately 100,000 hours of *V-G* data from one type of four-engine civil-transport airplane to determine the magnitude and frequency of occurrence of the gust loads and gusts. The normal accelerations differed by approximately 15% and the derived gust velocities by about 18% for the five operations investigated. The gust loads of the present operations were less than the loads experienced by other four-engine civil transports previously investigated, but the differences are not significant. The present data indicate only small differences due to seasonal effects and different operational utilization. From author's summary

1459. Stewart, W., Helicopter control to trim in forward flight, *Aero. Res. Counc. Lond. Rep. Mem.* 2733, 34 pp., Mar. 1950, published 1954.

A theoretical estimation of the flapping and feathering (cyclic pitch) to trim the helicopter rotor in forward flight is given and the equivalence of the two systems is shown.

The feathering amplitudes to trim the complete helicopter are then estimated and compared with experimental flight values obtained on the Sikorsky R-4B and S-51 helicopters. The effects of center-of-gravity position, fuselage pitching moment, etc., are considered and the delta-3-hinge effect is dealt with in an appendix. The effect of slipstream curvature on lateral control is included.

Satisfactory agreement of the theoretical and experimental results is obtained. In the longitudinal trim, the fuselage pitching moment in the presence of the rotor slipstream is a most important contribution. In the lateral trim, the induced velocity distribution and the tail rotor behavior have a large influence and must be taken into account. From author's summary

1460. Oliver, A. L., The performance of a multi-engine helicopter following failure of one engine during take-off or landing, *Aero. Res. Counc. Lond. curr. Pap.* 175, 15 pp., Oct. 1953, published 1954.

1461. Miele, A., On the nonsteady climb of turbojet aircraft, *J. aero. Sci.* **21,** 11, 781–783, Nov. 1954.

Considerable attention has been devoted in recent years to the study of the problems associated with the nonstationary climb of high-speed aircraft. Some of the minimal problems investigated are the following:

(1) The determination of the speed-height relationship $V = V(h)$ which minimizes the time necessary to fly an aircraft from a given combination of speed and altitude (V_1, h_1) to another combination of speed and altitude (V, h_2).

(2) The determination of the speed-energy height relationship $V = V(h_e)$ which minimizes the time necessary to fly an aircraft from a given energy height level (h_{e1}) to another energy height level (h_{e2}), with free choice of the terminal velocities, V_1, V_2.

According to the terminology of the calculus of variations, the first problem is a fixed end-points problem, while the second one, of lesser practical importance, is a free boundary-value problem. Mathematically analogous problems may be formulated for the climbing flight with minimum fuel consumption and for the steepest climb.

The writer analyzed the fixed end-points problems by using a transformation based on Green's theorem. This approach essentially avoided the difficulties inherent to the use of direct or indirect variational methods. Both problems of absolute optima and conditioned optima were handled in this way.

From author's summary

1462. Saelman, B., Airplane stopping distance, *J. aero. Sci.* **21,** 11, 790–792, Nov. 1954.

1463. Schmidt, R., The effects of air-pressure and temperature variations on the performance of high-velocity jet planes (in German), *Z. Flugwiss.* **1,** 4, 81–92, Sept. 1953.

The effects of pressure and temperature of the atmosphere on the performance of jet planes (level flight, rate of climb, take-off distance) are more pronounced and more complex than in the case of airplanes with internal-combustion engines. Special attention has to be given to compressibility effects. In the present paper a new method is developed for high-speed jet planes, using charts which enable the conversion of performance data to various values of pressure and temperature of the atmosphere.

From author's summary by P. Schwaar, France

1464. Sedney, R., and Zes, D., A method of analyzing dynamic test data, *Douglas Aircr. Co. Rep.* no. SM-14774, 27 pp., May 1953.

1465. Behrbohm, H., On a minimum time flight path with regard to stress and heat limitations, *SAAB Aircr. Co. Linköping, TN* 26, 26 pp., 1954.

As an ideal limiting case for tactical considerations the extremal flight paths are determined which minimize the time to fly from a point A to a point B in space under the following auxiliary conditions: Measuring the load strain in terms of dynamic pressure q and the temperature strain in terms of Mach number M, the flight shall be performed at q = const up to a certain critical altitude H^*, but at M = const above that altitude. This note gives a solution of the problem using $H^* = 11$ km and an exponential approximation of the air density-altitude law. The equations of the flight paths and the times required to fly along such paths can be given by very simple formulas. The practical applicability is discussed. From author's summary

Aeroelasticity (Flutter, Divergence, etc.)

(See also Rev. 1333)

1466. Clevenson, S. A., Widmayer, E., Jr., and Diederich, F. W., An exploratory investigation of some types of aeroelastic instability of open and closed bodies of revolution mounted on slender struts, *NACA TN* 3308, 44 pp., Nov. 1954.

Present and future use of pylon-mounted fuel tanks, military stores, and ramjet engines has raised the possibility of local aeroelastic instabilities of these bodies. Authors carried out low-speed wind-tunnel investigations on pylon-mounted streamlined bodies, open tubes, and on cylinders with various nose and tail fairings. Bending-torsion-type flutter, divergence, and nondestructive yawing oscillations were three types of instability observed. Mass unbalance, elastic-axis location, airstream density and afterbody shape of faired cylinders were found to be important factors. Calculations were also carried out using slender-body theory for the aerodynamic forces, but the results do not agree well with observed instability speeds and frequencies except for yawing oscillations. Authors conclude that boundary-layer separation or other viscous effects are important, since simple aerodynamic theory permitted no analytic flutter speed

for streamlined body, contrary to observed phenomena. Reviewer noted an apparent typographical error in absence of angular acceleration as a factor in first term of Eq. (2).
T. F. O'Brien, USA

1467. Timman, R., Linearized theory of the oscillating airfoil in compressible subsonic flow, *J. aero. Sci.* **21,** 4, 230–236, 250, Apr. 1954.

A previous paper by this author [AMR **5,** Rev. 1475] in which he analytically and numerically investigated the two-dimensional oscillating airfoil in subsonic flow had been criticized for two reasons: (1) The numerical values did not check well with results obtained by other methods; (2) the numerical values did not satisfy the reciprocity relation for nonstationary flow.

In the present paper author reports the detection of an error in the numerical calculation and shows that the analytical formulas do satisfy the reciprocity theorem. The proof for this is obtained by using an identity between different solutions of the boundary-value problem. L. Oestreicher, USA

1468. Woodcock, D. L., Aerodynamic derivatives for a delta wing oscillating in elastic modes, *Aero. Res. Counc. Lond. curr. Pap.* 170, 28 pp., 5 figs., July 1952, published 1954.

Aerodynamic derivatives have been calculated for a cropped delta wing having aspect ratio 3 and 90° apex angle, and oscillating with symmetric elastic modes in incompressible flow. . . . The derivatives are compared. . .with constant derivatives obtained on the basis of two-dimensional theory.
From author's summary by T. R. Goodman, USA

1469. Templeton, H., Control-surface flutter with the stick free, *Aero. Res. Counc. Lond. Rep. Mem.* 2824, May 1950, published 1954.

The determination of the stick-free flutter characteristics of a control system when the inertia of the stick is allowed for is considered. A method of solution is proposed which corresponds to impedance matching between circuit and control surface in the flutter condition. The method is applied, by way of illustration, to two typical cases, an elevator system and a servotab system, and the effect of variations in stick inertia and circuit stiffness is demonstrated. Conclusions drawn from these two cases are listed separately, but it is concluded generally that stick-free flutter can occur in the absence of stick-fixed flutter, and that the stick-free flutter characteristics may be quite different from those for the circuit-cut condition. From author's summary

Propellers, Fans, Turbines, Pumps, etc.

(See also Revs. 1277, 1373, 1461, 1463, 1497, 1506, 1520)

1470. Kubota, S., A method of calculating the form of steam-turbine runner blade with given pressure distribution (in Japanese), *Trans. Japan Soc. mech. Engrs.* **18,** 77, 33–36, Jan. 1953.

A conformal-transformation method of determining the form of wing lattice, given the pressure distribution together with the circumference-pitch ratio S/t and the inlet angle σ_1, is presented. The complex velocity potential W is assumed in the form: $\log q_s - i\sigma = \log dW/dz = \log(\zeta + e^{i\theta_L}) + (\tau/\pi)\log(\zeta - e^{i\theta_T}) - [1 + (\tau/\pi)]\log\zeta + \sum_{n=0}^{\infty}(-C_n/\zeta^n)$ where the unit circle $\zeta = e^{i\theta}$ in the ζ-plane corresponds to the wing profile in the z-plane, q_s and σ are the magnitude and direction of the velocity, and τ is the trailing edge angle (which is taken as zero in actual calculation). C_n's are determined from the given pressure distribution by Fourier analysis. A numerical example is worked out for a thick, cambered profile, obtaining a satisfactory result.
I. Imai, Japan

1471. Noyes, E. G., Jr., Factors influencing steam-turbine-generator unit overspeed, ASME Fall Meet., Milwaukee, Wis., Sept. 1954. Pap. 54—F-25, 25 pp.

Large turbogenerator sets are liable to overspeeding on loss of electrical load. Sources of energy producing overspeed are three: main steam supply from boiler, steam entrapped in high pressure turbine and reheater and connections, and steam resulting from evaporation of condensate in regenerative feedwater system as steam pressure at bleed points decays.

Author described equipment provided by his company (Westinghouse Electric Corp.) for controlling the first two of these sources of energy. He also gives analysis for calculating extent of overspeed as a result of action of all three sources. (See following review.)

Control method adopted is use of stop valves ahead of main throttle and ahead of intercept valves in hot reheat lines. All stop valves are in duplicate to permit routine testing while unit remains in service. Protection system using relief valves in reheat piping is analyzed to show disadvantage compared to adopted system.

Preprint suffers from minor errors in reproduction of equations. In Eq. (1), bar over radical should extend to include KE term. In Eq. (19) the closing square bracket is omitted after the parenthesis. M. A. Mayers, USA

1472. Eggenberger, M. A., Overspeed protection of reheat turbine-generators, ASME Fall Meet., Milwaukee, Wis., Sept. 1954. Pap. 54—F-26, 22 pp.

Large turbogenerator sets are liable to overspeeding on loss of electrical load despite closing of main stop valves because of expansion of steam trapped in reheater and piping.

Author presents method of step-by-step calculation of extent of overspeed from this source, making allowance for variation in stage efficiencies and losses, and also gives approximate method based on estimate of total shaft energy increase. (See preceding review.)

Other methods of control of overspeed, e.g., power-operated relief valves, automatic vacuum breaker, and house generator, are compared with use of reheat stop valves to show superiority of last. Type of reheat stop valves adopted by author's company (General Electric Co.) are illustrated and described.
M. A. Mayers, USA

1473. Kraft, E. A., Present-day steam turbines [Die neuzeitliche Dampfturbine], 7th ed. (3rd German), rev. and enlarged, Berlin, VEB Verlag Technik, 1954, viii + 403 pp., 366 figs.

1474. Steen-Johnsen, H., Future industrial turbine and its application, *Mech. Engng., N. Y.* **76,** 9, 727–730, Sept. 1954.

1475. McKone, T. D., and Hendrickson, R. L., Gas-turbine power-plant testing, ASME Fall Meet., Milwaukee, Wis., Sept. 1954. Pap. 54—F-35, 18 pp.

Paper describes the methods currently in use by the authors' company for evaluating the over-all performance of commercial gas-turbine power plants by tests in the factory before shipment. Facilities instrumentation and sample test results are included. A calculation system for correcting test performance to contract or guarantee condition is suggested.
From authors' summary

1476. Ringle, C. L., Reheat turbine overspeed protection, ASME Fall Meet., Milwaukee, Wis., Sept. 1954. Pap. 54—F-31, 10 pp.

1477. Yellott, J. I., Broadley, P. R., and Meyer, W. M., Acceptance and operational tests of a 4250-HP coal-burning gas turbine. Part I—Preliminary oil-fired operation, ASME Fall Meet., Milwaukee, Wis., Sept. 1954. Pap. 54—F-39, 16 pp.

1478. Yellott, J. I., Broadley, P. R., and Meyer, W. M., Acceptance and operational tests of a 4250-HP coal-burning gas turbine. Part II—Coal-fired operation, ASME Fall Meet., Milwaukee, Wis., Sept. 1954. Pap. 54—F-40, 19 pp.

1479. Mallinson, D. H., General performance calculations for gas turbine engines, *Aero. Res. Counc. Lond. Rep. Mem.* 2684, 58 pp., June 1946, published 1954.

Report summarizes the theoretical work carried out during the past few years aimed at discovering the potentialities of the gas turbine as a power plant in many fields of application, but especially as an aircraft power unit. To do this, the performance of the various modifications of the ideal gas-turbine cycle is considered in some detail, and the works of various authors are then combined and edited in order to depict the performance attainable by practical engines. The influence of component efficiencies on this latter performance is examined and the effects of modifications, such as reheating the gas after partial expansion or introducing a heat exchanger, are compared with the effects predictable from the ideal cycle calculations.

The association between the gas turbine and jet reaction as a means of aircraft propulsion is considered and the probable performance of several simple jet engines estimated over a speed range from 0 to 1500 mph. The influence of forward speed and altitude on the output and efficiency of the gas turbine is obtained and combined with the influence of varying operating conditions upon the propulsive efficiency of the jet to give the over-all performance of a jet-turbine combination.

Finally, a method of estimating the performance of a simple jet engine from the nondimensional characteristics of its components is detailed and the results of an example employing this method are used to illustrate the influence of several factors, such as propelling nozzle size, upon the equilibrium running conditions of such an engine. From author's summary

1480. Muntz, F. A. I., and Huber, R., The free-piston gas-generator turbine as a power plant for ship propulsion, *Trans. Inst. mar. Engrs.* **66,** 9, 201–215, 1 fig., 2 plates, Sept. 1954.

Authors describe the inherent characteristics of the free-piston gas-generator/turbine engine system and the advantages of the inward compressing types of gas generator.

The advantages of the free-piston gas-generator engine system, including its inherent low cost of manufacture, ease of installation, and good maintenance features, are outlined, likewise its requirements in respect to turbines and reverse-reduction gears. Reference is also made to future possibilities, in particular the advantages that are likely to accrue when a free-piston gas-generator/turbine is combined with a steam turbine.

From authors' summary

1481. Lindenhovius, H. J., Electronic equipment for permanent supervision of the mechanical operating condition of a turbine (in Dutch), *Ingenieur* **66,** 38, E.93–E.97, Sept. 1954.

Paper deals with electronic equipment for permanent supervision of the mechanical operating condition of a turbine. The quantities that are to be measured are the vibration of the bearings, the axial displacement of the shaft with regard to the housing, the expansion of the housing, and the eccentricity of the shaft.

The bearing vibrations are measured by means of seismic electrodynamic vibration pickups; for the measurement of all the other quantities, inductive-type displacement pickups are used.

A description is given of the main properties of these pickups and of the associated electronic recording equipment.

By means of an automatically rotating switch, all the quantities are measured and recorded successively, an alarm operating as soon as a dangerous limit is exceeded.

From author's summary

1482. Greatrex, F. B., Air intake efficiency, *J. roy. aero. Soc.* **58,** 525, 639–648, Sept. 1954.

1483. Keast, F. H., The development of the axial flow compressor for the Orenda engine, *Engng. J., Montreal* **37,** 9, 1082–1091, Sept. 1954.

1484. Lindros, E., Grand Coulee model-pump investigation of transient pressures and methods for their reduction, *Trans. ASME* **76,** 5, 775–781, July 1954.

In May 1951, when the first of six pumps of the Grand Coulee Dam was put in service, a defect of major concern was discovered. This unfavorable condition embodied objectionable discharge-line vibration. Investigation revealed that this was caused by transient pressure variation in the pump, and remedial measures incorporating reinforcement of the discharge lines were taken to minimize this condition. No previous investigation had been made of the offending transient pressure variation. The paper describes such an investigation, the test setup used, and reveals the difficulty encountered in applying instrumentation to obtain necessary data. From author's summary

1485. Kramer, J. J., and Stanitz, J. D., A note on secondary flow in rotating radial channels, *NACA TN* 3013, 33 pp., Oct. 1953.

A general vector differential equation for the vorticity component parallel to a streamline is derived for steady, nonviscous and incompressible flow in a rotating system. This equation is then simplified by restricting it to rotating radial channels and by making further simplifying assumptions. This simplified equation is used to solve for the secondary vorticity, the vorticity component parallel to the streamline, in three special cases involving different stream tube geometries; the results are presented in a series of figures. The secondary vorticity is shown to decrease with decreased absolute angular velocity of the fluid, decreased inlet total-pressure gradient, decreased length of relative flow path, and increased relative velocity.

From authors' summary

1486. Flugel, G., The optimum attainable efficiency of turbomachinery (in German), *ZVDI* **96,** 22, 752–755, Aug. 1954.

It is possible, through careful design and construction, to eliminate most of the through-flow losses in a turbomachine, except for the unavoidable wall friction and energy conversion losses.

Taking into account these two types of losses only, author derives expressions for the optimum attainable efficiency, which include some experimental coefficients. The formulas are given for single-stage machines; however, they can be applied, with the necessary modification, to multistage machines as well as to model experiments.

The difference between the calculated optimum efficiency and the actually attained efficiency can be considered as a measure of the quality of design and construction of the turbomachine.

K. Pilarczyk, USA

1487. Kasahara, E., A mapping theory of straight cascades of arbitrary blade sections, I (in Japanese), *Trans. Japan Soc. mech. Engrs.* **20**, 97, 577–581, Sept. 1954.

Author extends the reviewer's method of obtaining the mapping function which transforms the given airfoil into the unit circle so as to cover the case of a straight cascade of airfoils. The method is one of successive approximation and can be applied to cascades of highly cambered thick airfoils with fairly close spacing. Numerical examples treated are: (1) cascade of NACA 0024 airfoils with pitch-chord ratio $t/l = \pi/4$; (2) cascades of NACA 0012 airfoils with $t/l = \pi/2, \pi/3, \pi/4$; and (3) cascade of circular cylinders with pitch-diameter ratio of $2\pi/3$.

I. Imai, Japan

1488. Hudimoto, B., and Kubota, S., Wind-tunnel tests of steam and gas-turbine blades, 1st and 2nd reports (in Japanese), *Trans. Japan Soc. mech. Engrs.* **20**, 97, 582–589, 589–594, Sept. 1954.

In the first report, seven kinds of cascade of impulse turbine blades with aspect ratio of 3 are tested in low-speed wind tunnel. Force coefficients, flow direction behind the cascade, and loss coefficients are presented graphically for various pitch-chord ratios and angles of attack. Effects of surface curvature and roughness made with sand particles upon the surface pressure distribution are also considered. Roughness near the leading edge or on the upper surface has larger effect than that on the lower surface. In the second report, experiments are reported in which blade span and tunnel width are varied in order to investigate the effects of secondary flow on the cascade characteristics.

H. Tamaki, Japan

1489. Wojcicki, S., Investigation of the effect of the characteristic values of a subsonic ramjet engine on its performance (in Polish), *Arch. Bud. maszyn* **1**, 2, 165–186, 1954.

Author reports findings of tests performed to determine the effect of inlet contraction coefficient (cp_0), air excess coefficient (λ), and widening of the diffuser (cp_z) on performance of ramjet engine. Following is the suggested way of using the above characteristic values to select optimum parameters when calculating the engine from data presented on the report: Choose air excess coefficient at which the combustion is to take place and then, from graph of thrust vs. λ at constant values of outlet to inlet ratios F_4/F_1, select the approximate value of F_4/F_1. The known F_4/F_1 permits selection of optimum cp_0 from graph of thrust against cp_0 at various constant ratios of F_4/F_1. Value of optimum coefficient (xp_z) can be obtained from graph of F_4/F_1 vs. λ.

The applicability of results is limited to ramjet engines with a small-diameter combustion chamber, constant coefficient of loss of flow in the diffuser and exhaust cone, and constant mechanical losses in the combustion chamber.

B. Hawrylyshyn, Canada

Flow and Flight Test Techniques

(See also Revs. 1346, 1438, 1439, 1443, 1454, 1475, 1481, 1488, 1489, 1523)

1490. Schmidt, R., Air logs for measuring subsonic and supersonic flight velocities (in German), *Z. Flugwiss.* **1**, 7, 175–183, Dec. 1953.

Usual measurements of flight velocity involve determination of dynamic pressure as well as of static pressure and temperature. Certain difficulties of this method, particularly in the transonic region, can be avoided if flight velocity is measured directly by means of an air log, i.e., a small propeller that turns freely in the air stream. This instrument determines primarily the distance traveled, and flight velocity is found by measuring its speed of revolution. Unfortunately, the unavoidable vulnerability of this instrument due to its delicate mechanical construction makes it suitable only for flight tests.

An ideal air log indicates independently of Mach and Reynolds number. The mechanical and aerodynamical requirements to approach ideal operation with sufficient accuracy and for wide ranges of speed and altitude are discussed, and photoelectric and electromagnetic methods of counting revolutions without load on the propeller are outlined. A new air log, developed at the Instituto Aerotécnico, Cordóba, Argentina, is briefly described. At sonic flight velocity, its propeller reaches a speed of about 50 rps. Author estimates that errors of measurement due to viscosity and compressibility do not exceed 0.5% under any flight conditions for altitudes up to 30 km.

G. Rudinger, USA

1491. Nyden, R. C., Calibration wind tunnel, *Instruments* **27**, 9, p. 1463, Sept. 1954.

Developing and manufacturing an electronic anemometer for measuring air speeds down to 0.5 mph requires a means for calibrating and checking finished instruments conveniently and accurately. This called for a small wind tunnel with most of the requirements pertaining to larger wind-tunnel installations—a continuously variable range of air speeds; the air must pass the testing area with as little turbulence as possible; the air speed must be measurable with an accuracy better than that of the equipment to be calibrated therein.

To meet these objectives a unit has been built. The speed range is from 0.5 to 65 mph; the driving power requirement is 5 hp. The tunnel is constructed from timber and $^5/_8$-in. 5-ply plywood, although certain sections are formed from other materials. Over-all length is approximately 17 ft; height is 11 ft. The width at the widest point is about 5 ft.

From author's summary

1492. Newby, K. W., Barnes, E. G., and Bottle, D. W., Model tests on an air interchange system for removing engine exhaust products from a wind tunnel, *Aero. Res. Counc. Lond. Rep. Mem.* 2639, 32 pp., Mar. 1948, published 1954.

1493. MacDougall, A. R. C., and Haines, A. B., 24-ft wind tunnel tests on a propeller with NACA 16 series sections. Test results and analysis into mean lift-drag data, *Aero. Res. Counc. Lond. Rep. Mem.* 2602, 18 pp., Aug. 1948, published 1954.

1494. Seddon, J., and Haverty, L., Note on an application of the tilting plate method of Mach number variation for wind tunnel tests at low supersonic speeds, *Aero. Res. Counc. Lond. curr. Pap.* no. 168, 7 pp., 11 figs., Mar. 1953, published 1954.

When a flat plate mounted in the working section of a supersonic wind tunnel is inclined at an angle to the stream, there exists a region above the surface of the plate in which the Mach number is constant and different from the main stream value. In limited circumstances this region may be used as the test section and it is possible, by varying the angle of the plate, to obtain a continuous variation of test Mach number with the one fixed tunnel nozzle. This method of Mach number control can be particularly useful for making wind-tunnel tests near $M = 1.0$.

The report describes an application of the method to a study of internal flow problems of side intakes at transonic speeds in a small supersonic tunnel. By arrangements involving the use of three or four tunnel nozzles, a continuous Mach number range from 0.5 to 1.6 is made available, apart from a gap between 0.97 and 1.04.

From authors' summary

1495. **Holder, D. W., and North, R. J., Schlieren methods for observing high-speed flows,** *Aero. Res. Counc. Lond. curr. Pap.* no. 167, 27 pp., July 1953, published 1954.

Paper discusses the present state of knowledge concerning the use of schlieren and direct-shadow methods for the visualization of high-speed flow, the emphasis being on the use of the methods in wind-tunnel experiments. The techniques for observing flows which are two-dimensional or which possess axial symmetry have reached an advanced stage of development and are satisfactory for most investigations of this kind; recent progress is reviewed in part I.

In contrast, comparatively little work has been done on the development of techniques for visualizing the flow round finite wings and wing-body combinations. Several methods which may be useful for the study of flows of this type are described briefly in part II, but further work is necessary before the value of these methods can be assessed. From authors' summary

1496. **Thompson, J. R., and Kurbjun, M. C., Evaluation of the accuracy of an aircraft radio altimeter for use in a method of airspeed calibration,** *NACA TN* 3186, 15 pp., May 1954.

1497. **Herzig, H. Z., Hansen, A. G., and Costello, G. R., A visualization study of secondary flow in cascades,** *NACA Rep.* 1163, 51 pp., 1954.

Flow-visualization techniques are employed to ascertain the streamline patterns of the nonpotential secondary flows in the boundary layers of cascades, and thereby to provide a basis for more extended analyses in turbomachines. The three-dimensional deflection of the end-wall boundary layer results in the formation of a vortex within each cascade passage. The size and tightness of the vortex generated depend upon the main-flow turning in the cascade passage. Once formed, a vortex resists turning in subsequent blade rows, with consequent unfavorable angles of attack and possible flow disturbances on the pressure surfaces of subsequent blade rows when the vortexes impinge on these surfaces.

Two major tip-clearance effects are observed, the formation of a tip-clearance vortex and the scraping effect of a blade with relative motion past the wall boundary layer. The flow patterns indicate methods for improving the blade tip-loading characteristics of compressors and of low- and high-speed turbines.

From authors' summary

Thermodynamics

(See Revs. 1390, 1430, 1463, 1474, 1477, 1479, 1482, 1498, 1503, 1515)

Heat and Mass Transfer

(See also Revs. 1309, 1394, 1465, 1515, 1521)

1498. **Knudsen, J. G., and Katz, D. L., Fluid dynamics and heat transfer,** *Engng. Res. Bull.* 3, Sept. 1953; Engng. Res. Inst., Univ. of Mich., 1954, 243 pp. $3.50.

Authors state the purpose of this book is "an attempt to bring together those phases of fluid dynamics which are fundamental to an understanding of the mechanism of convection heat transfer." They have been successful in this purpose and, furthermore, have provided a valuable source of practical information on fluid dynamics and forced-convection heat transfer associated with flow through a variety of channel shapes and configurations. Only single-phase flow is considered.

The book consists of three parts: 1. The mechanism of fluid flow; 2. The energy relationships of flowing fluids; 3. Convection heat transfer. About half the book is devoted to the first part, in which velocity distributions are presented for laminar and turbulent flow through tubes, annuli, between planes, over immersed bodies, and through heat exchangers. Where theoretical derivations exist, they are presented or referenced.

The second part occupies about one fourth of the book. This deals with pressure losses associated with laminar and turbulent flow through the shapes discussed in part 1. The friction factor is defined in the conventional manner, and theoretical and experimental relationships are given for the various channels.

The third part contains an excellent discussion of the similarities between the transfer mechanisms for heat, mass, and momentum. A review of the empirical relationships for convection is presented, and the discrepancies between the various equations at low Prandtl numbers are illustrated. The method of calculating heat-transfer coefficients from velocity profiles is described for circular tubes and smooth annuli. The methods are illustrated by calculations of heat-transfer coefficients for liquid metals, for which the conventional empirical formulas are not valid. Empirical data for heat transfer to banks of plain and finned tubes are summarized briefly. A bibliography of 129 references is a valuable part of the book.

The various parts of the book should be read in sequence in order to preserve the continuity of ideas presented. The book should be of equal value to the student and to the practicing engineer who wishes to bring his knowledge of the subject up to date. S. Zivi, USA

1499. **Gee, L. J., and Seban, R. A., An investigation of the effect of a step in the surface temperature on the heat transfer to a laminar boundary layer,** ASME Semi-Ann. Meet., Pittsburgh, Pa., June 1954. Pap. 54—SA-54, 12 pp.

Local heat-transfer coefficients have been determined experimentally for a surface upon which the boundary-layer flow was laminar and upon which there occurred a sudden increase in the surface temperature. The boundary layer was formed by the flow of air over the surface of a plate, and in most of the investigations the velocity was almost constant over the entire surface of the plate. Experimental conditions thus approached those of the analysis of Rubesin on the effect of a step in the surface temperature on the heat transfer from the surface of a flat plate at zero incidence to the stream. The experimental results show acceptable general correspondence with that theory.

From authors' summary by Y. S. Touloukian, USA

1500. **Hara, T., Heat transfer from a flat plate in longitudinal flow of water** (in Japanese); *Trans. Japan Soc. mech. Engrs.* 20, 92, 257–261, Apr. 1954.

Author assumes that (1) temperature difference between plate and general flow is not too large; (2) density and specific heat are constant; (3) viscosity is proportional to T^{-6} (T absolute temperature); (4) thermal conductivity is proportional to T^m, where m varies with temperature of general flow. Using Blasius and Pohlhausen solutions for constant physical properties as zero approximation, author solves numerically the laminar boundary-layer equations by a perturbation method, and gives formulas for skin-friction coefficient and Nusselt number, containing the term linear in the temperature difference between plate and general flow. H. Tamaki, Japan

1501. **Bäckström, M., Nusselt number in the whole region in forced convection** (in Swedish), *Klytekn. Tidskr.* 13, 1, 11–12, Feb. 1954.

In the very extensive literature on heat transfer it is often hard

and laborious to make an accurate choice of formulas, which are given by different authors and are valid for different ranges of the dimensionless numbers involved. Further, in the N_{Re} region where laminar and turbulent flow are met, the data available are rather meager.

For engineering use the author has tried to boil down all these data, from a great variety of sources, to a single chart and one auxiliary diagram covering N_{Re} from 1 to 10^6, N_{Pr} from 10^{-4} to 10^4, and *length/diam* from 1 to 10^3.

The way of plotting the chart mentioned gives an opportunity to estimate by interpolation the heat transfer in the intermediate N_{Re}-region mentioned.

The chart is very elegantly built up, easy to handle, and gives a very good survey over the whole field of heat transfer in pipe flow. As far as reading accuracy goes, reviewer believes that the reproduction of the chart is too small, but copies of the original size are available from the author (address: Kungl. Tekniska Högskolan, Stockholm). C. E. Lenngren, Sweden

1502. Kuga, O., A note on the heat transfer in liquid metal (in Japanese), *Trans. Japan Soc. mech. Engrs.* **19,** 88, 6–10, Dec. 1953.

Theoretical formula is derived for the turbulent heat transfer in pipe flow of liquid metal, having high thermal conductivity and small Prandtl number. Author assumes that the heat transferred in radial direction per unit area is constant in both laminar sublayer and transition layer and is proportional to the distance from the axis in the turbulent core, and obtains the temperature by using the experimental velocity profile. Both molecular and turbulent conductivity are taken into account for the turbulent core. Author's formula for the heat-transfer coefficient reduces to that of von Kármán when molecular conductivity is neglected in the core flow. Agreement with the existing experimental results is satisfactory. H. Tamaki, Japan

1503. Hansen, C. F., Note on the Prandtl number for dissociated air, *J. aero. Sci.* **20,** 11, 789–790, Nov. 1953.

This paper views critically the estimate of Moore [AMR **6,** Rev. 1339] of Prandtl number for air at elevated temperatures where dissociation will be present. Author also discusses the estimates of Crown [NAVORD Rep. 2299, 1952] based on the Euken relation. Author regards values of Moore as much too large owing to neglect of variation of K/μ due to dissociation, and values of Crown are questioned since $C_p - C_v$ does not remain constant when dissociation occurs.

Author then gives own formulation based on kinetic gas theory, and treating dissociated air as a mixture of mol fraction n_1 of molecular gas and mol fraction n_2 of atomic gas. Viscosity and conductivity are then evaluated from kinetic theory of nonuniform gases, with some approximations, and heat capacities from equilibrium properties of dissociated air. Resulting Prandtl number values, up to 7000 K, are compared with those of Moore and Crown, showing drastic disagreement with Moore. Crown's values differ from the author's by less than 40%. Onset of dissociation in intermediate temperature range causes perceptible lowering of Prandtl number. Author concludes Prandtl number for dissociated air remains in the range 0.5 to 1.0.

S. Way, USA

1504. Yuge, T., On the temperature field of the flow with vortexes. Report 1. Cross flow around a circular cylinder (in Japanese), *Mem. Inst. high Speed Mech. Tôhoku Univ.* **10,** 93, 43–50, Oct. 1953.

Temperature field around a heated circular cylinder placed in a uniform flow of a viscous fluid is calculated numerically for the Reynolds number $Re = 20$ and Prandtl number $Pr = 0.733$. First, by the method of finite differences due to Thom, the velocity field is determined numerically, which reveals the occurrence of a pair of standing vortexes in the wake. Then the temperature field is determined numerically also by the use of Thom's method. It is concluded that, for such a slow motion, the reverse flow region behind the cylinder causes no essential hindrance to the heat transfer other than that due to the fact that it should be regarded as a fluid at rest. I. Imai, Japan

1505. Ostrach, S., New aspects of natural-convection heat transfer, *Trans. ASME* **75,** 7, 1287–1290, Oct. 1953.

1506. Gardner, A. J., An introduction to the thermal problems of turbojet engines for supersonic propulsion, Symposium on the Thermal Barrier, ASME Ann. Meet., New York, Nov. 28–Dec. 3, 1954. Paper 54—A-155, 7 pp.

The ranges of temperatures that are to be expected in planning the design of turbojet engines for use in supersonic aircraft and the effects of these anticipated temperatures on basic engine components are discussed. A typical aircraft operating envelope is developed. The magnitude and source of heat, the temperature rise through the compressor, the heat added per pound of air flow, and the effect of flight speed on the effective and optimum compression ratio are discussed in a nonmathematical treatment with the aid of graphs. The paper will serve as an initial reading on the subject. C. R. Mischke, USA

1507. McClellan, C. H., Melting of bodies due to aerodynamic heating, Symposium on the Thermal Barrier, ASME Ann. Meet., New York, Nov. 28–Dec. 3, 1954. Paper 54—A-157, 8 pp.

Of the various approaches to the aerodynamic heating problem of bodies re-entering the atmosphere, the possibility of the body absorbing the heat and the toleration of partial melting is discussed. Tests upon simple Wood's metal bodies at Mach 6.9 are illustrated photographically. The method of prediction of the time of melting is discussed and calculations are compared to experimental results. Author concludes that melting is an orderly and reproducible process, which occurs at the nose of solid bodies of revolution and extends to other parts of the surface when the body is hollow. C. R. Mischke, USA

1508. Adams, H. W., Temperature problems of equipment in high-speed aircraft, Symposium on the Thermal Barrier, ASME Ann Meet., New York, Nov. 28–Dec. 3, 1954. Paper 54—A-131, 6 pp.

Paper discusses insulation without cooling, air cycle cooling, turbojet bleed cooling, water evaporative cooling, and fuel cooling as applicable to high-speed aircraft. The cooling systems' performance at 20,000, 70,000, and 120,000 ft for various aircraft speeds is discussed and graphically illustrated. The paper will serve as introductory reading. C. R. Mischke, USA

1509. Hoff, N. J., The thermal barrier—structures, Symposium on the Thermal Barrier, ASME Ann. Meet., New York, Nov. 28–Dec. 3, 1954. Paper 54—A-207, 6 pp.

"Thermal barrier" is a phrase coined to allude to the real and potential menace of aerodynamic heating to high-speed flight. Author discusses aerodynamic heating, heat transfer, thermal stresses, thermal buckling, effect of high temperatures on properties of materials, stress distribution in presence of creep, creep failure in tension, and creep buckling in a simple, nonmathematical treatment which will serve admirably as an initial reading in the area for persons not well versed in aeronautical prob-

lems intensified by high-speed flight. The role of time in supersonic aircraft structural failure is made clear.

C. R. Mischke, USA

1510. **Loebel, F. A., Recent developments in packaged fire-tube boilers,** ASME Fall Meet., Milwaukee, Wis., Sept. 1954. Pap. 54—F-27, 13 pp.

1511. **Lachner, E. J., The application of automatically controlled water-tube packaged steam generators,** ASME Fall Meet., Milwaukee, Wis., Sept. 1954. Pap. 54—F-28, 7 pp.

1512. **Hindenlang, A. W., Selection of control equipment for packaged water-tube steam generators,** ASME Fall Meet., Milwaukee, Wis., Sept. 1954. Pap. 54—F-29, 8 pp.

1513. **Kazmierski, E. A., Design and operation of fully automatic shop-assembled boilers,** ASME Fall Meet., Milwaukee, Wis., Sept. 1954. Pap. 54—F-30, 8 pp.

1514. **Willman, B. T., Brock, J. E., Sibbitt, W. L., and Hawkins, G. A., Measurement of gun barrel temperatures,** *Instrum. Automat.* **28,** 1, 106–108, Jan. 1955.

A method has been developed for simultaneously measuring temperatures at numerous positions on the bore surface and in the barrel wall of an automatic gun during firing. The construction of sensitive thermocouples which were sufficiently rugged for this application is described. An accurate knowledge of these temperatures is of importance in barrel life studies, thermal stress analyses, and heat-transfer investigations.

From authors' summary

Combustion

(See also Revs. 1478, 1510, 1511, 1512, 1513)

1515. **Energy transfer in hot gases,** *Nat. Bur. Stands. Circ.* 523, iv + 126 pp., Mar. 1954. $1.50.

This book consists of a series of papers presented at an N.B.S. symposium held in Sept. 1951. The papers are:

(1) *A. G. Gaydon* (Imperial College, London), Processes of electronic excitation in relation to flame spectra. (2) *G. A. Hornbeck and R. C. Herman* (Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.), Studies of some polyatomic flame bands. (3) *P. J. Dyne* (Natl. Research Council, Ottawa, Canada), Emission spectra of polyatomic free radicals. (4) *H. P. Broida* (N.B.S., Washington, D. C.), Distributions of OH rotational intensities in flames. (5) *S. S. Penner, M. Gilbert, and D. Weber* (Jet Propulsion Lab., Calif. Inst. of Technology, Pasadena), Spectroscopic studies of low-pressure combustion flames. (6) *G. H. Dieke and H. M. Crosswhite* (Johns Hopkins Univ., Baltimore, Md.), Studies of emission and absorption in flames. (7) *S. Silverman* (Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.), Energy distribution of CO molecules in CO-O_2 flames. (8) *W. S. Benedict and E. K. Plyler* (N.B.S., Washington, D. C.), High-resolution spectra of hydrocarbon flames in the infra-red. (9) *S. S. Penner* (Jet Propulsion Lab., Calif. Inst. of Technology, Pasadena), Infra-red emissivity of diatomic gases. (10) *R. H. Tourin* (Industrial Scientific Co., New York, N. Y.), Infra-red spectra of thermally excited gases. (11) *B. Lewis* (Bureau of Mines, Pittsburgh, Pa.), Present position of the theory of flames. (12) *J. R. Arthur and D. T. A. Townsend* (B.C.U.R.A., Leatherhead, Surrey, England), Some reactions of atomic H in flames. (13) *R. H. Wilson, Jr., J. B. Conway, A. Engelbrecht, and A. V. Grosse* (Temple Univ., Philadelphia, Pa.), Temperature of the hydrogen-fluorine flame. (14) *B. Karlovitz* (Bureau of Mines, Pittsburgh, Pa.), Effect of flame-generated turbulence on heat transfer from combustion gases. (15) *H. K. Sen,* Astrophysicist's concept of temperature.

This collection of papers presents a useful cross section of the research being done in 1951 on flame spectroscopy, as well as some miscellaneous information on other aspects of flame research. However, most of the original work described in this book has already appeared in print elsewhere in the interval 1951–1954.

R. Friedman, USA

1516. **Gross, R. A., Aerodynamic determination of flame speed,** *J. aero. Sci.* **21,** 2, 139–141, Feb. 1954.

A method for determing flame velocity in a flat two-dimensional flame by pressure measurements is described. An equation is derived from mass and momentum conservation equations as follows:

$$S = [1/(\lambda - 1)]\ \{(2/\rho_1)\ [\lambda_1 \Delta_2 p_t - (\lambda - 1)_t \Delta_s p_1]\}^{1/2} \qquad [1]$$

where S is flame velocity, ρ_1 is density at the upstream side, ρ_2 is the density at the downstream side, $\lambda = \rho_1/\rho_2$, ${}_1\Delta_2 p_t$ is the total pressure change between points 1 and 2, and ${}_t\Delta_s p_1$ is the difference between total and static pressure at point 1. The quantities ${}_1\Delta_2 p_t$ and ${}_t\Delta_s p_1$ were measured, while λ was calculated from thermodynamic data.

Flame velocities for propane-air mixtures are presented. The method is sensitive to small errors in pressure measurement, which limits accuracy of method. Reviewer finds values differ by about 10% from those of Dugger [*J. Amer. chem. Soc.* **72,** p. 5271, 1950] measured by burner tube method.

Method has advantage of being point-type measurement and gives independent check on flame velocities as measured by other techniques.

Marjorie W. Evans, USA

1517. **Klein, G., Equations of a simple flame solved by successive approximations to the solution of an integral equation,** *Univ. of Wis., Nav. Res. Lab., Dept. of Chem., Rep.* ONR-8, 27 pp., June 1954.

Author develops interesting method for computation of ideal one-dimensional flame, starting from Hirschfelder's theory [AMR **7,** Rev. 3748]. He treats problem of stationary flame with first-order reaction, formerly solved by conventional methods.

Differential equation for temperature gradient, derived from conservation laws, is transformed into integral equation, considering boundary conditions

$$g = q\ {}_\tau\!\int^{\tau_\infty} [R(x,\tau)]/g d\tau - (\tau_\infty - \tau)$$

where g is temperature gradient, q eigenvalue parameter connected with burning speed, τ reduced temperature, x mole fraction of combustible, R function for reaction rate. This is to be solved (with additional differential equation for x). If boundary conditions for g and x are to be obeyed, this is possible for definite value of q only. Plausible approximation for g is used under integral, better approximation found by integration, etc. Procedure converges rather rapidly, 3 to 5 consecutive steps being sufficient. . Author calculates eigenvalue for different values of reduced diffusion coefficients δ, finds q depending linearly on δ for $0 \geq \delta \geq 1$.

Author is first in applying usual methods for solving integral equations to problems of burning speed. Reviewer sees main value of paper in this fact. Efficiency of method will become evident if applied to reactions of 2nd and higher order and to reactions involving more than one independent reactant. Paper is very clear in spite of a few misprints in formulas.

C. Franze, Germany

1518. Klein, G., Equations of a simple flame solved by successive approximations to the solution of an integral equation. Part II: Second order reaction. *Univ. of Wis., Nav. Res. Lab., Dept. of Chem., Rep.* ONR-13, 25–60, Sept. 1954.

This is a continuation of the paper reviewed in preceding review. Author extends expression for rate to reactions of second order. Different possibilities of transforming original equation into integral equation are discussed. Most suitable method of transformation has been selected and used for further calculations (cf. preceding review).

Author shows that expression used for rate of reaction may be attributed to flame with chain mechanism

$$A \rightleftarrows B$$
$$A + B \rightarrow B + C$$

Here it has been assumed that B is always in equilibrium with A. Thus the concentration of B can be expressed by that of A and it is sufficient to consider a single concentration as variable, in addition to the temperature gradient.

Reviewer thinks that application to reactions with more than one independent reactant might prove difficult but very valuable, if possible. C. Franze, Germany

1519. Burgoyne, J. H., and Hirsch, H., The combustion of methane at high temperatures, *Proc. roy. Soc. Lond.* (*A*) **227,** 1168, 73–93, Dec. 1954.

1520. Simonson, J. R., Some combustion problems of the dual-fuel engine, *Engineering* **178,** 4625, 363–366, Sept. 1954.

1521. Gray, F. A., and Brooks, S. H., An investigation of reheating furnace design and performance, *J. Iron Steel Inst. Lond.* **178,** part 3, 223–266, Nov. 1954.

Tests on a continuous reheating furnace have shown, apart from the well-known effect of output on furnace efficiency, that increased thickness of billets required more fuel (higher flue-gas losses). The importance of furnace pressure has been confirmed. The progress of combustion through the furnace was studied in relation to gas flow, furnace pressure, and gas/air ratio. A technique for continuous measuring (by thermocouples) of the upper and lower surface temperature of billets passing through the furnace was developed, enabling the determination of the pattern of temperature distribution in the stock and of heat-transfer rates. Two-zone heating for all billets $\geqq$ 3 in. is suggested. As a result, redesigning of the furnace is suggested (new burners, roof, recuperator, insulation, improved gas tightness), enabling 20% fuel savings and increased output.

W. Gumz, Germany

1522. Kennedy, E. H., The burning of sulphate, soda, and sulphite waste liquors, ASME Fall Meet., Milwaukee, Wis., Sept. 1954. Pap. 54—F-32, 13 pp.

1523. Bellman, D. R., Humphrey, J. C., and Male, T., Photographic investigation of combustion in a two-dimensional transparent rocket engine, *NACA Rep.* 1134, 12 pp., 1953.

Motion pictures at camera speeds up to 3000 frames per sec were taken of the combustion of liquid oxygen and a hydrocarbon fuel in a transparent-sided rocket engine. This 100-lb-thrust engine consisted basically of metal contour and injection plates clamped between two plastic sheets. This design provided an essentially two-dimensional engine with a view of the entire combustion chamber. Various injectors, parallel jets, and impinging jets were used in order to study varied types of combustion.

Oxygen-hydrocarbon propellant combinations provided sufficient combustion luminosity to use direct photographic methods. An increase in the number of holes of the parallel-jet injectors tended to increase the uniformity of combustion, but all the injectors showed nonuniformity of combustion. Turbulence projections increased the apparent mixing and circulation of propellants. Variation of ignition delay, apparently from improper mixing, caused starting explosions, midrun explosions, and other short-duration transient phenomena. Both low- and high-frequency oscillations were recorded during the runs, and some of the oscillations corresponded to the resonant frequencies of the chamber. Photographic measurements of gas velocities provided data from which chamber combustion temperatures could be calculated. Patterns in the plastic windows provided additional information regarding gas-flow paths and qualitative indications of temperature variations at the walls.

From authors' summary

Acoustics

1524. Friedlander, F. G., Diffraction of pulses by a circular cylinder, *Comm. pure appl. Math.* **7,** 4, 705–732, Nov. 1954.

Author investigates behavior of pressure behind a diffracted front as a function of time since arrival. Cylinder is chosen as simplest obstacle where diffraction is not primarily an edge effect. Author develops solution for incident pulse from instantaneous point source and shows application of plane pulses and short harmonic waves. Method involves Laplace transform of the Green function defined on a Riemann surface with an infinity of sheets on which the diffracted fronts propagate without interacting. Investigation of asymptotic forms of the transform reveals an essential singularity of the pressure behind the front. Calculations in the deepest shadow show the cylinder to be ineffective as a shield for pulses of length about half a radius; further calculations for plane pulse show how quickly the diffraction effect fades away from the deepest shadow.

F. J. Berry, England

1525. Young, J. E., Transmission of sound through thin elastic plates, *J. acoust. Soc. Amer.* **26,** 4, 485–492, July 1954.

Paper discusses two problems. The first is the transmission through an elastic plate set in an infinite baffle. A formal scheme of calculation is given expressed in terms of the appropriate Green's functions. Allowance can be made for imperfect clamping at the edges by a perturbation calculation. As the problem is rather idealized, no comparison has proved possible with experiment.

The second problem discussed is the transmission through an elastic plate in an infinite duct. The method of Ingard [title source, **26,** p. 99, 1954] is used and adapted to the case of an elastic plate. Experiments are described for various thicknesses of plate and a variety of edge conditions. The results are compared with theory in the case of a plate with a clamped edge; good agreement is found. J. M. Jackson, Scotland

1526. Krautkrämer, J., Advances in material testing with ultrasonics (in German), *Z. Metallk.* **45,** 4, 154–157, Apr. 1954.

This report on recent improvement of ultrasonic testing devices concerns mainly those used in various kinds of production control. A new head has variable sensitivity, allowing a more accurate determination of the depth of any flow. Another instrument makes the localization of discontinuities in welds easier. The accuracy and the range of thickness gages were also improved. The quartz

of many of the new instruments is now protected against wear. A process based upon the absorption of the ultrasonic waves was developed to determine mechanical properties of metals. All these improvements make it now possible to use the method more extensively in production control, and the simplifications of the instruments allow their use by less skilled personnel.

Compare paper by same author [AMR **5**, Rev. 2365].

D. Vasarhelyi, USA

1527. Bolz, G., On a very small ultrasonic probe for the determination of acoustic fields in liquids (in German), *Z. angew. Phys.* **6**, 2, 54–59, Feb. 1954.

The theoretical and experimental behavior of very small piezoelectric probes, made of tourmaline, is described. Such a crystal, which possesses a single piezoelectric axis, is almost perfectly nondirectional in its response if the dimensions of the crystal face are small compared with the wave length of the sound. This property makes the tourmaline probe superior to a quartz or Rochelle salt probe. Barium titanate could also be used in this fashion. Some measurements of the diffraction field from cylindrical objects are given, as well as a detailed comparison of this probe with those based on magnetostrictive or thermal principles.

R. T. Beyer, USA

Ballistics, Detonics (Explosions)

(See Rev. 1514)

Soil Mechanics, Seepage

(See Rev. 1356)

Micromeritics

(See Revs. 1405, 1406)

Geophysics, Meteorology, Oceanography

(See also Revs. 1373, 1396, 1397, 1417, 1458, 1463, 1480)

1528. Sorokin, L. W., Urysson, W. O., Rjabinkin, L. A., and Dolizkij, W. A., Textbook of geophysical methods for oil exploration [Lehrbuch der geophysikalischen Methoden zür Erkundung von Erdölvorkommen] (translated from Russian), Berlin, VEB Verlag Technik, 1953, 578 pp., 231 figs. DM 34.

This book, published in East Berlin, is intended to serve as a textbook in applied geophysics for geology students. It presents a reasonably comprehensive survey of four major methods of geophysical exploration for oil: gravitational, magnetic, electric, and seismic. The fifth and final section is devoted to the geological interpretation of geophysical observations. For each of the four methods, the physical background, typical apparatus, field methods, and computational procedures are described.

It may not be safe to assume that the book fully describes the true state of the art of geophysical prospecting as it existed in Soviet Russia, even at the time of original publication (1950)—any more than a similar work published elsewhere would—despite the fact that the book lauds the open scholarly approach of the Russians, as opposed to the secretive commercial attitude of the capitalists. For one example, in a discussion of the interpretation of gravity surveys the problem of determining depth of basement is covered by one sentence in which Soviet scholars are credited with learning how to find the interface between a surface layer and a half space of different density. For another example, the circuit diagrams of the seismic amplifiers are complete except for a "black box" containing the automatic gain-control circuitry.

It is certainly not safe to assume that the history of the development of geophysical prospecting, as presented in this book, is correct even for Soviet Russia. The Russians are too intelligent not to have taken advantage of developments arising elsewhere, even though the lengthy discussions of priorities rarely mention non-Russian names. Apparently the German translator could stand only just so much of this; he added a footnote of his own to the history of seismology, just mentioning Mintrop as having started work in this field in 1919. Incidentally, despite the preoccupation with historical developments, the text is completely devoid of references, and the bibliography lists only fifteen items, all recent and all in Russian. Fortunately for the reader, the authors are technical men rather than skilled propagandists. The propaganda is easily recognized and ignored; it is scattered through the book in a few indigestible lumps and does not insidiously permeate the entire text.

The apparatus and methods described appear fairly conventional. In some respects they may be a little superior in performance or thoroughness to what we ordinarily employ; in others they are inferior. The average American geologist does not customarily use the calculus in discussing gravity problems, but he does have available gravimeters with a limiting sensitivity better than the 0.1 of 0.2 Milligal mentioned in this book. The discussion of seismic computations is quite extensive and thorough, but the physical and mathematical background material on wave propagation and the acoustical properties of the earth medium is quite meager. The discussion of electrical resistivity theory, apparatus, and methods is somewhat better balanced. Natural potential difference and electromagnetic induction observations are described briefly, with no time wasted on radio-frequency methods.

There are other less welcome omissions. The discussion of magnetic surveying apparatus and methods included no fluxgate equipment nor any aerial surveying. Offshore exploration methods are not included, although an example of results appears in a discussion of seismic sections. Radioactivity measurements are not mentioned, though perhaps this is just as well in view of the present state of the art in oil prospecting. Except for seismic velocity surveys, well logs and their correlation with other geophysical observations are not discussed. Reproducible seismic recording is only briefly mentioned as a promising method of the future. Apparently in 1950 the Russians were not much further advanced than the capitalists—at least as revealed in capitalist publications. The equipment and analysis methods described bear a remarkable resemblance to those of Rieber.

By and large, the authors of this book succeeded fairly well in what they set out to do: to provide a college textbook on geophysical prospecting for geology students. The variations from section to section in relative emphasis—as between theory, apparatus, methods of operation, and interpretation—is unfortunate, but perhaps inevitable from a plurality of authors. One might wish that a similar, though more up-to-date book were available in English.

F. G. Blake, Jr., USA

1529. Ogura, Y., and Miyakoda, K., The theory of three-dimensional turbulent diffusion, *J. meteor. Soc. of Japan* (II) **32**, 5/6, 143–159, May/June 1954.

Author studies title problem. He claims to have shown that "the feature of the diffused cloud near the source is controlled solely by the energy spectrum in the intermediate wave-number range."

C. C. Lin, USA

1530. Rigby, E. C., Marshall, J. S., and Hitschfeld, W., The development of the size distribution of raindrops during their fall, *J. Meteor.* **11**, 5, 362–372, Oct. 1954.

Lubrication; Bearings; Wear

(See also Rev. 1268)

1531. Corey, T. L., Rowand, H. H., Jr., Kipp, E. M., and Tyler, C. M., Jr., Behavior of air in the hydrostatic lubrication of loaded spherical bearings, First Ann. Conf. ASME-ASLE, Baltimore, Md., Oct. 1954. Pap. 54—LUB-8, 11 pp.

Hydrostatic lubrication has proved useful for bearings operating under high unit loads at low speeds. Theoretical relationships which have been developed for hydrostatic lubrication with oils and other liquids are not applicable to gases. Authors report an empirical study of air-lubricated steel balls in spherical seats. Data are given for balls of 2, 4, and 6 in. in diam operating in 140° angle-of-contact seats with a 60° included angle hydrostatic pad. The minimum pressure necessary to support a given load, the lift as a function of pressure, and the flow rate as a function of pressure were determined for air-line pressures up to 80 psi.

Semiempirical relationships for the lift and flow rate as functions of pressure were developed from the data. The validity of extrapolating these equations to other ball diameters was not determined. A simplified theoretical analysis established upper and lower bounds for the minimum pressure required to support a given load. The experimental value, for the 60° pad, was approximately equal to the average of the theoretical upper and lower bounds. W. H. Goldthwaite, USA

1532. Kantrowitz, A., An automatic control for close clearances in rotating machinery, ASME Semi-Ann. Meet., Pittsburgh, Pa., June 1954. Pap. 54—SA-25, 15 pp.

Paper presents simple servomechanism to maintain close clearance between moving and stationary parts of machinery in order to achieve a dependable sealing action. Clearance is maintained in spite of thermal distortion of the parts. To achieve this control, clearance is measured by its effect on the flow of hot gas through the clearance space. This same hot gas also flows through thermal actuators which support and align the stationary member. Decreased clearance at any point results in a reduction of hot-gas flow through the appropriate actuator and a consequent rise in temperature and expansion of the actuator in a direction which corrects the clearance. A simple example is shown and accompanied by experimental verification. Formulas are presented to aid in design to meet specifications. Unlike many servomechanisms, in this case no dynamic stability problems arise; hence paper treats only the static operation.

R. Kochenburger, USA

1533. Nemeth, Z. N., and Anderson, W. J., Investigation of temperature limitation of various lubricants for high-temperature 20-millimeter-bore ball bearings, *NACA TN* 3337, 31 pp., Jan. 1955.

Twenty-millimeter-bore tool-steel ball bearings, equipped with either a beryllium copper or an Inconel cage, were operated with liquid and with solid lubricants at temperatures from 100 to 1000 F at a speed of 2500 rpm and a thrust load of 110 lb. Solid lubricants were more effective than fluid lubricants at the higher temperatures. Graphite provided effective lubrication to 1000 F, with bearings equipped with either a beryllium copper or an Inconel cage; molybdenum disulfide, to 850 F with a bearing equipped with an Inconel cage. A silicone-diester blend, the best high-temperature liquid lubricant, provided effective lubrication to 700 F and allowed operation of the bearing at 850 F, although the bearing operation was rough and friction torque was high. From authors' summary

1534. Rylander, H. G., and Wight, E. M., The influence of solid particles in the oil to babbitt, copper-lead, and aluminum bearings, ASME Fall Meet., Milwaukee, Wis., Sept. 1954. Pap. 54—F-11, 8 pp.

Paper describes an experimental investigation of copper-lead and aluminum bearings operating with oil containing solid particles of molybdenum sulphide, red rouge, and corundum. It was found that the load-carrying capacity of a bearing could be increased or decreased over 100% by the addition of solids to the oil supply. These results are explained in terms of surface finish, coefficients of friction for specific ZN/P values, bearing seizure loads, wear rates, particle size, and particle concentration. A comparison with babbitt operating under similar conditions shows the particular advantages and disadvantages of these three materials. From authors' summary

1535. Abramovitz, S., Turbulence in a tilting-pad thrust bearing, First Ann. ASME-ASLE Conf., Baltimore, Md., Oct. 1954. Pap. 54—LUB-7, 8 pp.

Using water as a lubricant, experiments were made with a tilting-pad thrust bearing. It was found that the friction torque increased abnormally when the rubbing speed exceeded what appeared to be a critical value. This abnormal torque indicated the possible effect of turbulence in the hydrodynamic film between the runner and pads. An analysis was made of experimental data based on the work of G. I. Taylor. These data show the effect on friction torque of the variables of fluid viscosity and sliding speed for both laminar and turbulent film conditions.

From author's summary

Marine Engineering Problems

1536. Lackenby, H., B.S.R.A. Resistance experiments on the "Lucy Ashton," *Engineer, Lond.* **198,** 5150, 5151; 488–489, 534–536, Oct. 1954.

Part III of report on full-scale resistance measurements of ex-paddle steamer *Lucy Ashton* sponsored by British Shipbuilding Research Association for correlation with model towing tank results. Paper deals with resistance tests of vessel fitted alternatively with two types of twin-screw propulsion appendages, namely, (a) open shafts and struts and (b) shaft bossings. It compares these with data from model tests of six models ranging in length from 9 feet to 30 feet.

Two previous papers describing experimental techniques were published in *Trans. Instn. Naval Arch.*, Great Britain, p. 40, 1951, and p. 350, 1953.

Results show marked scale effect on resistance of appendages and indicate increment of resistance for either bossings or shafts and struts over that for bare hull resistance of full size ship to be about one half that for normal model sizes, i.e., 12 to 24-ft length. Scale effect for bossings showed variation over speed range which differs from previous results obtained with models only. Author believes difference is due to fact that bossings are aligned with flow in latter case while in present tests they were inclined to flow, thus producing more turbulence and eddying.

In general, tests confirmed current practice in British laboratories for estimating full-scale appendage resistance from model.

Experiments described are the first of their kind to be carried out and represent invaluable contribution to science of ship hydrodynamics. Author has presented information in a clear and easily readable manner. R. B. Couch, USA